8800 PowerScope®
User's Guide

BMI
The Power of Quality

ISO 9001 Certified

8800 PowerScope User's Guide

This symbol indicates maximum input voltage to instrument not to exceed 600 Vrms.

Protective ground (earth) terminal.

WARNING!

The installation instructions in this manual are for use by qualified personnel only. *Do not install this instrument on a power line unless you are qualified to do so.* High voltages that cause burns and lethal shocks are present during power monitoring. *When making connections to power lines, always connect the safety earth ground first. Use standard high-voltage, high-current safety precautions.*

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FCC Requirement

FCC Part 68 Registration

This equipment may have a modem installed for remote operation over the telephone lines. This modem is registered with the FCC and complies with Part 68 of the FCC rules. Connection of this equipment to the public-switched telephone network is regulated by the FCC and these regulations require the following:

1. Connection of the modem in this equipment to party lines and pay telephones is prohibited.

2. If requested, the following information concerning the modem must be made available to the telephone company:

   Modem Manufacturer:
   DataTrek Corp.
   4505 Wyland Drive
   Elkhart, IN 46516

   Model No.: 2424DTCSTH1

   FCC Registration: HSD2TC-10818-MD-E

   Ringer Equivalence (REN): .8B

   Telephone No.: The telephone number to which the modem is connected.

3. The REN is used to determine the quantity of devices which may be connected to the telephone line. Excessive REN's on the telephone line may result in the devices not ringing in response to an incoming call. In most, but not all areas, the sum of the REN's should not exceed five (5.0). To be certain of the number of devices that may be connected to the line, as determined by the total REN's, contact the telephone company to determine the maximum REN for the calling area.

4. If the modem causes harm to the telephone network, the telephone company will notify you in advance that temporary discontinuance of service may be required. But if advance notice isn't practical, the telephone company will notify you as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary.

5. The telephone company may make changes to its facilities, equipment, operations, or procedures that could effect the operation of this equipment. If this happens, the telephone company will provide advance notice in order for you to make the necessary modifications in order to maintain uninterrupted service.

6. If telephone trouble is experienced during or after the connection of the modem, disconnect the modem from the line and see if the problem ceases. If it does, then the modem is causing the problem. In this case, please contact DataTrek at **(219) 522-8000** for repair and warranty information. If the trouble is causing harm to the telephone network, the telephone company may request that you remove the equipment from the network until the problem is resolved.

7. The manufacturer (DataTrek) must make any necessary repairs to the modem in order to maintain valid FCC registration. Do not attempt to repair or service the modem other than to return it to BMI who will arrange for service from DataTrek Corp.

To Begin Using Your PowerScope . . .

Unpack your PowerScope

Make sure you completely remove all packing materials from around your unit. Visually inspect your unit for any damage that may have occurred in shipment.

Check to be sure you have received all of the following items with your new PowerScope:

- ☐ 8800 PowerScope User's Guide (this book)
- ☐ single-phase voltage measuring cable
- ☐ cable set on a cable pallet (1 each red, blue, white and yellow e-z hook cables, 4 black e-z hook cables, 1 green/ground alligator cable, 3 blue jumper cables, and 1 yellow jumper cable)
- ☐ AC power cord
- ☐ 2 rolls of thermal paper
- ☐ warranty card and warranty registration card

If you are missing any of the above items, contact BMI Sales at 415 570-5355.

Connect your PowerScope to Monitor Single-Phase Voltage and Current

You will use one blue jumper cable, one yellow jumper cable with a green ground plug, one single-phase voltage measuring cable with black, red, and green connectors on one end and an AC wall plug on the other, and a SmartProbe (current probe).

WARNING! You are working with high voltages that cause burns and lethal shocks. Connect the safety earth ground first. *Use standard safety precautions.*

1. Plug the green ground connector on the measuring cable into the yellow jumper cable connector and plug these joined connectors into the Channel 2 black/negative socket. Plug the green ground plug at the other end into the green/ground socket.

2. Plug the red connector into the Channel 1 red/positive socket.

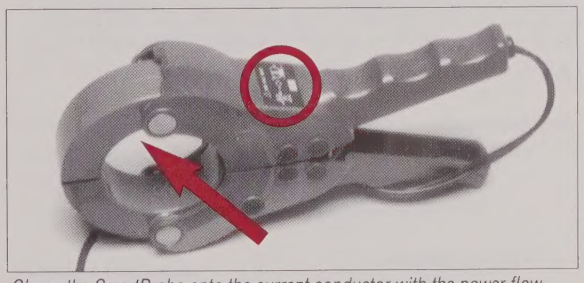
3. Plug the black connector first into one of the connectors on the blue jumper cable, then insert these joined connectors into the Channel 1 black/negative socket. Plug the other end of the blue jumper cable into the Channel 2 red/positive socket.

4. Connect your SmartProbe to the Channel 1 current connector and clamp the probe around the current conductor for the load you are monitoring.

   Be sure to match the power flow of the SmartProbe (see label on probe) to the power flow of the conductor. You can also use a model 151-2 line splitter from Simpson Electric to separate the conductors and make the attachment of a SmartProbe easier.

5. Finally, plug the three-prong AC wall plug of the measuring cable into a wall socket.

The Simpson 151-2 line splitter separates the conductors for easy SmartProbe attachment.



Clamp the SmartProbe onto the current conductor with the power flow indicator label on the probe matching the power flow of the conductor.

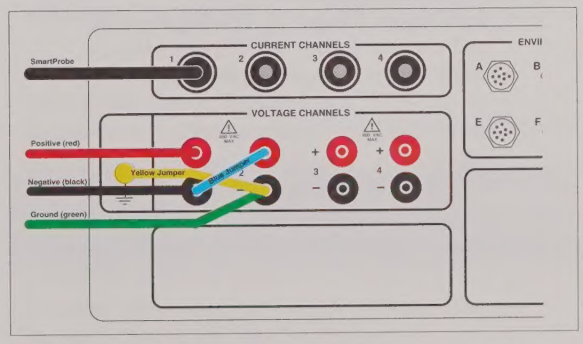


Figure 1.1: The PowerScope single-phase connection for monitoring voltage and current

The Impatient User's Guide continues on the next page . . .

Impatient User's Guide

continued from page 1-1 . . .

Plug In your PowerScope
Use the AC power cord to plug your unit into a suitable power source. After plugging your PowerScope in, the display should read [Idle] or [Monitor].

Press the Recall Setup Button
Use the **Value Up/Value Down** arrows to position [Default] in the display. Default restores reasonable threshold settings for monitoring single-phase power.

Press the Scroll Down Arrow
Once you have positioned[Recall Mem: Default] in the display, press the **Scroll Down** arrow to enter your selection.

Press the Snapshot button
This will provide you with graphs of line-to-neutral voltage and current, and neutral-to-ground voltage.

Begin Monitoring
Press the **Monitor** button followed by the **Scroll Up** arrow. A Threshold Report will print showing the present settings.

Create a Disturbance
Unplug the voltage measuring cable from the wall outlet then quickly plug it back in. Your PowerScope will report this disturbance by printing a disturbance graph.

For Assistance . . .
. . . with power connections;
see Chapter 4, Connecting to Power.
(complete cable connection diagrams)

. . . with thresholds;
see Chapter 15, Thresholds.
(tables of preset and recommended thresholds)

. . . with reports and graphs;
see Chapter 3, page 3-5, Printing Reports,
and Chapter 5, page 5-8, Reports Menu,
and Chapter 7, Reports and Graphs.

Helpful Hint: Resetting your PowerScope
To quickly reset your PowerScope at any time, press the **Cancel Printer** button followed by the **Scroll Up** arrow.

8800 PowerScope with optional Smartprobes

The 8800 PowerScope

Power line disturbances disrupt and damage today's sophisticated electronic equipment. The 8800 PowerScope is the best power disturbance analyzer for capturing and graphing power line disturbances on both voltage and current simultaneously.

The PowerScope monitors the line continuously for all potentially damaging power disturbances. When a disturbance is detected, the PowerScope uses its built-in high-resoution thermal printer to print an easy to read and understand graph of the disturbance. Each graph includes the date, time, amplitude, and duration of the disturbance. The PowerScope will automatically zoom the disturbance to the ideal viewing resolution.

Capable of measuring single- and three-phase power systems, the PowerScope monitors for sags, swells, impulses, waveshape faults and power failures. Default thresholds are built in for all power types, or the user can program manual thresholds for customized monitoring.

The PowerScope uses independent monitoring systems for each channel. This allows for simple in-field board-swap service, and greater monitoring flexibility. Two environmental channels are included with each voltage and current channel, and a host of optional probes connect through them for monitoring temperature, temperature and humidity, radio frequency interference (RFI), and more.

Simultaneous Voltage and Current
Voltage and current are monitored simultaneously, providing you with a thorough look at your power system at all times. This greatly enhances your power quality troubleshooting capabilities. Without simultaneous voltage and current measurement, you would need two power line monitors (one for voltage and one for current), or one monitor that you change and reconnect for voltage measurement and then current measurement.

SmartProbes
Current measurements are performed using optional BMI SmartProbes. SmartProbes are up to 10 times more accurate than standard current probes. All necessary calibration information for the probe is contained within an in-line descriptor module that compensates for the inherent inaccuracies in the probe.

Menus
All normal operating parameters are set and modified using a menu system. All menus are viewed in the display window on the front panel. Access to the menus is obtained by pressing the **Menus** button, and are viewed, modified, and selected using the **Value Up/Value Down** buttons, the **Scroll** arrows, and the alpha/numeric keypad. Menus and their use are explained more fully in Chapter 5, *Menu Layouts.*

Meters
Instantaneous readings of voltage, current, frequency, and high frequency noise can be viewed in the display window on the front panel using the **Meters** button. Scroll through the meter readings using the **Scroll** arrows.

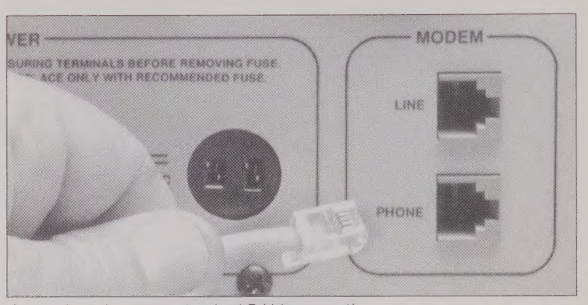
Meter readings include: RMS voltage for each phase connected; RMS current for each phase connected; frequency; high frequency noise; temperature (if probe connected); humidity (if probe connected).

Option Packages
Option packages increase the monitoring and reporting capability of your PowerScope. They can be configured into your unit at time of purchase or added later, which may require the unit to return to the factory for installation.

Storage Option Package
The Storage Option Package places a 3.5" double sided, double density, IBM compatible MS DOS format, 720 kB diskette drive into the PowerScope. With the Storage Option package, you can store graphs and reports to diskette. The PowerScope can play these back at any time. With the diskette drive installed, the built-in thermal printer can be left on to print or turned off to save paper. For more information on using the diskette drive, see Section 3, *Setting Up Your PowerScope.*

2 About Your PowerScope

Diskette Drive for Storage Option Package



Internal modem uses standard RJ11 connections

BMI's PowerTalk View™ software is included with the Storage Option Package. Diskettes used in your PowerScope can be read by an IBM PC AT or compatible computer using PowerTalk View software. PowerTalk View is described in detail in Chapter 6, *Networking Your PowerScope*, and in a separate publication, the *PowerTalk User's Guide.*

To add the Storage Option Package after original purchase the unit must be returned to the factory.

Harmonics Option Package
The Harmonics Option Package provides full harmonic analysis capability to your PowerScope. High-speed FFTs analyze voltage and current harmonic distortion. This includes an auto-ranging spectrum analyzer.

The Harmonic Option Package sets your PowerScope to monitor for harmonics up to 2000 Hz. Therefore, when monitoring at 60 Hz you will be measuring up to the 33rd harmonic (40th at 50 Hz and 5th at 400 Hz). Amplitudes of individual harmonics are reported as a percentage of the fundamental. The amplitude and phase position is given for each individual harmonic.

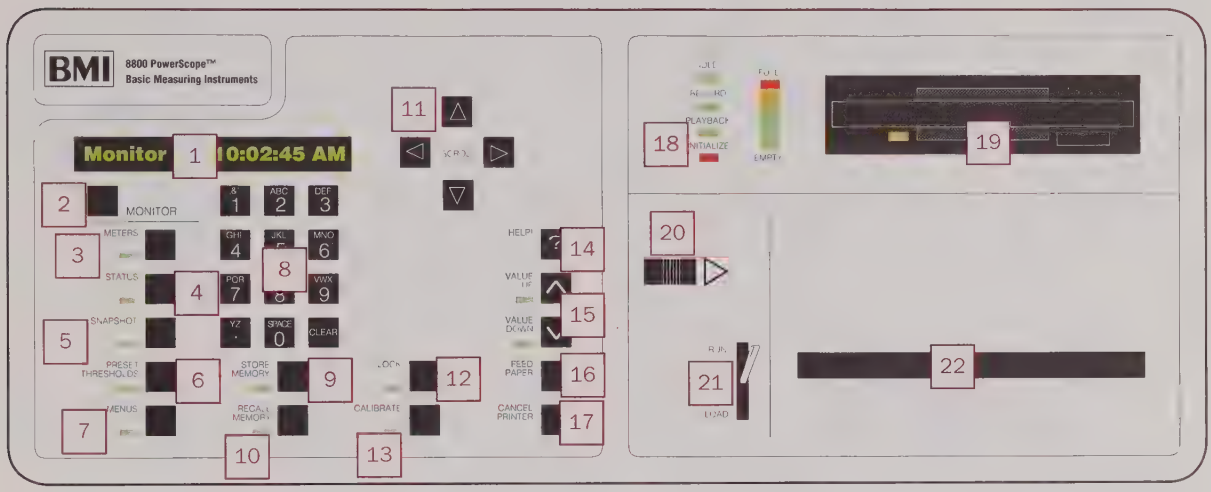
The Package provides snapshots of the harmonic spectrum and total harmonic distortion. THD is also provided as a meter reading.

To add the Harmonics Option Package after original purchase, the unit may need to be returned to the factory. Contact BMI Technical Support for assistance and more information.

Communications Option Package
This Package places an internal auto-dial, auto-answer modem into your PowerScope. This modem allows your PowerScope to communicate over phone lines.

You can link PowerScopes with modems together via phone lines. Remote communications using modems is covered in Chapter 6, *Networking Your PowerScope.*

The Communications Option Package can be added after original purchase by returning the unit to the factory.



PowerScope Front Panel

1 **Display Window** - shows meter readings and menus.

2 **Monitor** - puts unit into monitor mode.
Monitor followed by **Scroll Up** arrow prints threshold report and then puts unit into monitor mode.

3 **Meters** - displays realtime readings of RMS voltage and current, frequency, HFN, and environmental probe readings in display window.

4 **Status** - prints RMS voltage, RMS current, frequency, HFN, and environmental probe reports for each channel.
Status followed by **Scroll Up** arrow prints instrument serial number, board name, hardware and firmware revision, status of communications, harmonics, and storage options, and battery and paper supply status.

5 **Snapshot** - prints instantaneous snapshot of voltage and current waveshapes.
Snapshot followed by **Scroll Up** arrow prints THD and harmonics spectrum for each connected voltage and current channel.

6 **Preset Thresholds** - press to review and select from preprogrammed threshold settings.

7 **Menus** - press to access menus.

8 **Alpha/Numeric Keypad** - for entering values in menus and thresholds.

9 **Store Memory** - stores up to 3 instrument setups to memory.

10 **Recall Memory** - selects stored instrument setups for monitoring.

11 **Scroll Arrows** - moves you through menus and meter readings.

12 **Lock** - locks and disables front panel.
Lock then **Clear** unlocks front panel.

13 **Calibrate** - provides calibration status for unit and any SmartProbes attached.
Calibrate followed by **Scroll Up** arrow accesses the Calibration Menu.

14 ***Help!*** - gives useful advice about setting up the PowerScope.

15 **Value Up/Value Down** - use to view menu choices.

16 **Feed Paper** - advances paper.

17 **Cancel Printer**- cancels the report or graph currently printing.
Cancel Printer followed by **Scroll Up** arrow resets unit.

18 **Diskette Drive Indicator Lights** - show status of drive and diskette (present when Storage Option Package has been installed).

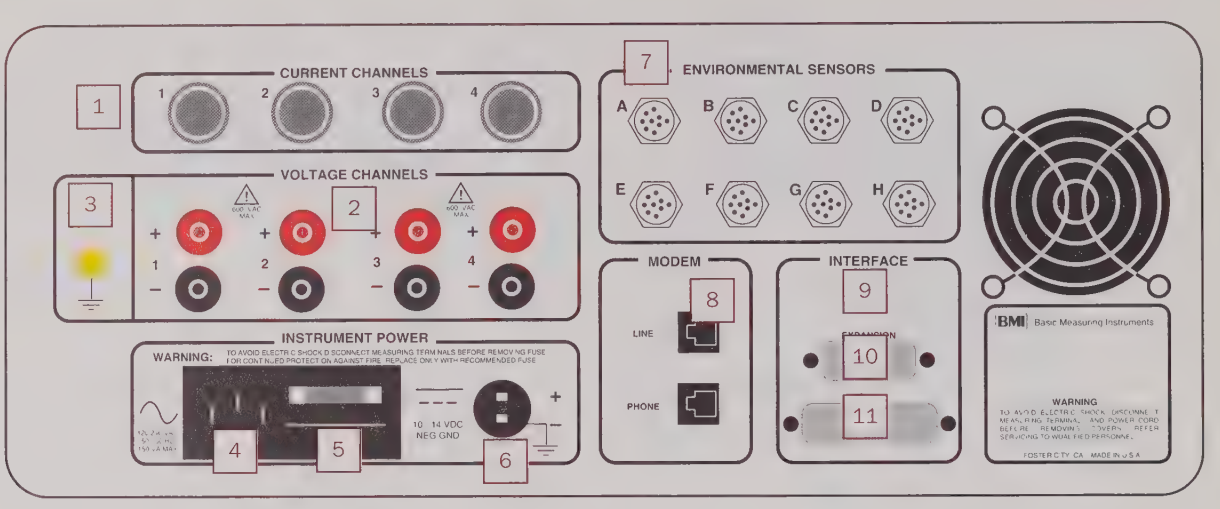
19 **Diskette Drive** - 3H inch DS, DD, MS DOS IBM compatible 720 kB format (when Storage Option Package has been installed).

20 **Printer Door Release** - push to right to open printer door.

21 **Run/Load lever** - engages and disengages printer assembly for paper loading.

22 **Printer** - high resolution thermal printer prints on 4H inch wide thermal printer.

2 About Your PowerScope



PowerScope Rear Panel

1 **Current Channels** - connections for SmartProbe inputs

2 **Voltage Channels** - safety connectors for voltage connections

3 **Ground Connection** - accepts BMI voltage ground cable

4 **Power Input** - accepts AC power cord

5 **Voltage Supply PC Card** - sets the supply voltage to accept nominal voltages of 120 Vac, 240 Vac, or 277 Vac

Voltage Supply PC Card Setting

Line Freq.	120 V	240 V	277 V
60 Hz	100 V - 145 Vac	200 V - 277 Vac	230 V - 277 Vac
50 Hz	100 V - 125 Vac	200 V - 255 Vac	230 V - 277 Vac
400 Hz	110 V - 155 Vac	210 V - 277 Vac	245 V - 277 Vac
Fuse	2 A, 250 Vac	1 A, 250 Vac	1 A, 250 Vac

6 **DC Power Supply Input** - accepts 11 to 16 Vdc input

7 **Environmental Channels** - accepts BMI environmental probes

8 **Modem** - connections for internal modem (when installed)

9 **Expansion** - future enhancements

10 **Auxillary** - future enhancements

11 **RS-232** - connections to IBM PC ATs and compatibles, another PowerScope, or external modem

Setting Up Your PowerScope

3

Unpack your PowerScope
Unpack and inspect your unit for any damage that may have occurred in shipment. Check to be sure you have received all of the following items:

- ☐ Single-phase voltage measuring cable
- ☐ Cable set on a cable pallet (1 each red, blue, white and yellow e-z hook cables, 4 black e-z hook cables, 1 green/ground alligator cable, 3 blue jumper cables, and 1 yellow jumper cable)
- ☐ AC power cord
- ☐ 2 rolls of thermal paper
- ☐ Warranty card and warranty registration card

If you are missing any of the above items, contact BMI Sales at **415 570-5355**.

Using the Setup Menu
The Setup Menu allows you to input the characteristics of your monitoring session. Press the **Menus** button once to access the setup menu. Use the **Scroll Up/Scroll Down** arrows to move through the menu. Use the **Value Up/Value Down** buttons to select from the available options for each menu item. Use the alpha/numeric keypad to enter names and numbers as necessary.

Within the Setup Menu you will enter the site name. Your PowerScope will print the assigned site name on each graph and report printed. If no site name is entered during setup the PowerScope will default to the last name used or to BMI 8800 SITE (if no name has ever been entered).

You will also be given the option of printing or clearing any summary reports that may be resident in memory from the previous monitoring session. If there are summary reports in memory to print, your first menu item will be [Summary Rpts: Print]. If you press the **Scroll Down** arrow, the reports will print and you can then continue with the Setup Menu. If you use the **Value Down** button to select [Summary Rpts: Clear] followed by the **Scroll Down** arrow, the reports will be cleared from the memory and you can continue with the Setup Menu.

Other user-defined information supplied through the Setup Menu includes power type, nominal frequency, line-frequency deviation threshold, high voltage threshold, low voltage threshold, high and low current threshold (if SmartProbe is attached), impulse threshold, neutral-to-ground voltage swell threshold, neutral-to-ground impulse threshold, and high frequency noise disturbance threshold.

Using the Key Operator Menu
The Key Operator Menu lets you set the administrative details of your PowerScope. These details include date and time, centigrade or farenheit temperature scale, and more.

Press the **Menu** button once to display [Menu: Setup], then press the **Value Up/Value Down** buttons until [Menu: Key Operator] is displayed. Use the **Scroll Up/Scroll Down** arrows to move through the menu selections.

You will also enter values for the following parameters: minimum duration for waveshape faults, minimum amplitude of waveshape faults, resolution for waveshape fault and initial waveshape graphs, hysteresis, automatic or manual impulse ranging, estimated impedance of the power line, temperature units, and internal UPS support time (these are preset at the factory and are rarely changed).

Day, month, and year are entered separately, and the user can define the U.S. standard for date reporting (Jul 16 1991) or the European standard (2 Dec 1991). Time can be set to AM/PM (12:00 midnight to 11:59 AM, and 12:00 noon to 11:59 PM) or 24 hour (0:00 to 23:59) displays.

The 3 memories available to the user are named for easy access. The PowerScope will default these names to Memory#1, Memory#2, and Memory#3. The user can rename them (usually to a name that denotes the monitored system that the parameters are set for) in the Key Operator Menu. The memories can also be protected from accidental change. After naming the memory, the next menu selection allows you to set the memory to Read Only (allows use of the memory only, no changes can be made), or Read/Write (full access to use and change memory). The naming and protection menu selections will be repeated for all 3 memories.

Suggested UPS Support Time
The PowerScope uses an internal NiCad battery UPS backup system. This system engages when power is lost to maintain memories and data, and to continue PowerScope activity. The support time is adjustable in 1 minute increments from 1 minute to 15 minutes. We suggest setting your UPS at 2 to 5 minutes to allow for accurate power failure recording while avoiding battery drain from printing reports or graphs during the UPS support time.

Setting Up Your PowerScope

DC Operation
The 8800 PowerScope is capable of operating off of a 12 volt DC voltage source - such as a car battery - for a limited period of time (based on the capacity and charge of the battery). A DC power input is provided on the rear of the PowerScope, and a DC power cord is available from BMI. The AC power and external PC are configured so that either can supply power to the instrument.

Using the Report Menu
Reports can be turned on or off at user discretion. Access this menu by displaying [Menu: Setup] in the display window then pressing the **Value Up/Value Down** buttons until [Menu: Report] is displayed. Because the report options change according to the power type selected in the Setup Menu, access the Report Menu after completing your input in the Setup Menu.

You can select from 1, 3, 6, 12, or 24 hour strip charts, or turn them off completely.

Options for RMS disturbance reports, impulse disturbance reports, high frequency noise disturbance reports, additional voltage signal reports (when using an AC/DC/ Impulse probe), and frequency signal disturbance reports are: Off (no disturbance reports will be printed but readings will be reported textually in the summary reports), Text or Graph (only text reports or disturbance graphs printout), hour (strip charts only will print every 1, 3, 6, 9, 12, or 24 hours), Both (strip charts and text reports/graphs will print).

More About Menus
Press the **Menu** button once to access menus, then use the **Value Up/Value Down** buttons to move between menus. Once you've selected a menu to work in, use the **Scroll Up/Scroll Down** arrows to move between menu selections. Use the **Value Up/Value Down** buttons to select from preset options within a menu selection and the alpha/numeric keypad to enter in numbers and letters. After you've made your menu selection or entered the data, pressing the **Scroll Down** arrow enters that information.

Chapter 5 contains full diagrams of all menus. Menus that are added with Option Packages to control storage and communications are explained later in this chapter (*Using the Diskette Drive*, and *Using the Modem*).

Meter Readings

Pressing the **Meters** button displays instantaneous readings of the signal being monitored in the display window. Use the **Scroll Up/Scroll Down** arrows to move up and down through the readings. Use the **Scroll Left/Scroll Right** arrows to move left and right from channel to channel.

Meter readings in order top to bottom, left to right:

RMS voltage, channel 1	RMS voltage, channel 2	RMS voltage, channel 3	RMS voltage, channel 4
RMS current, channel 1	RMS current, channel 2	RMS current, channel 3	RMS current, channel 4
Frequency, channel 1	Frequency, channel 2	Frequency, channel 3	Frequency, channel 4
HFN, channel 1	HFN, channel 2	HFN, channel 3	HFN, channel 4
Temperature (w/probe)	<Temperature>	<Temperature>	<Temperature>
Humidity (w/probe)	<Humidity>	<Humidity>	<Humidity>
Time (hh:mm:ss)	Time (hh:mm:ss)	Time (hh:mm:ss)	Time (hh:mm:ss)

< > = placeholder, indicates no value shown here

Setting Up Your PowerScope

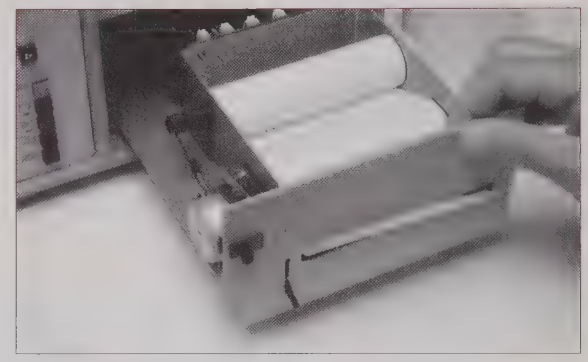
Loading Paper

The PowerScope comes standard with a 4.5" wide high-resolution thermal printer installed. Thermal paper is shipped with the unit, and additional rolls and cases can be ordered directly through BMI.

Because the thermal paper is sensitive to heat, it should be kept out of direct sunlight and away from heat sources. We suggest it be stored inside a closed cabinet or box in a cool, dry area.

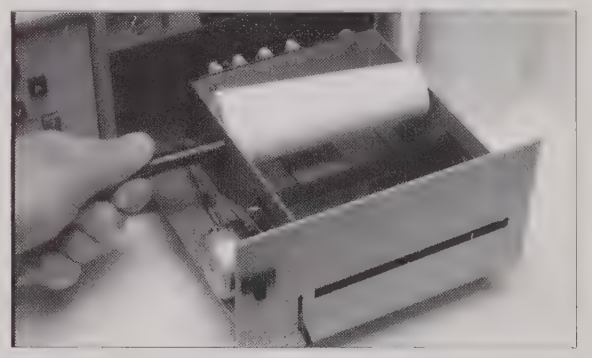
The thermal paper is sensitized for printing on one side only. The following paper loading sequence demonstrates how to properly load the paper for printing.

IMPORTANT! Notice the direction from which the paper feeds off the roll and into the printer. If the paper is loaded differently and the non-sensitized side is fed through against the printer mechanism, the paper will not image and will be blank as it exits the printer.



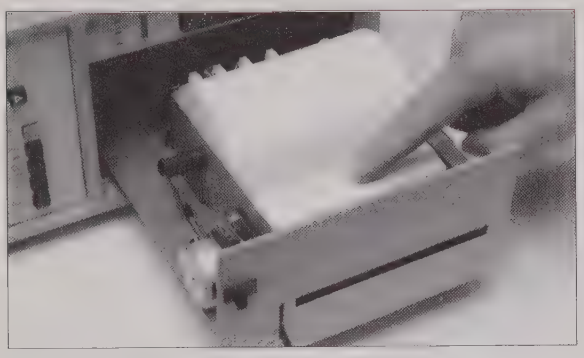
1. Move the Run/Load lever to the load position, push the printer door release to the right, and pull the printer assembly out until it stops.

2. With the lever in the load position, gently pull any remaining paper out through the opening in the printer door.

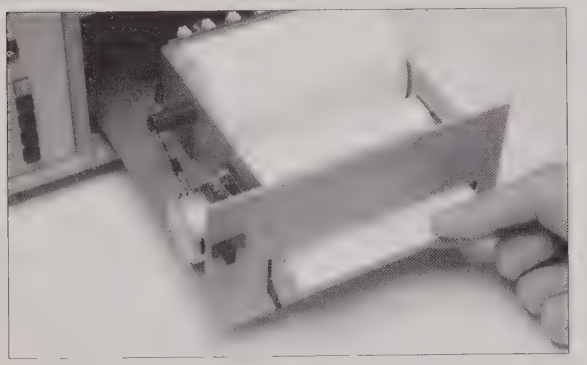


3. Grasp the knob on the end of the paper roll spindle and pull it to the left to release it from the right side of the printer assembly.

4. Remove the old core and place a fresh roll of thermal paper on the spindle while carefully threading the spindle through the hole on the left side of the printer. The spindle should snap into place on the right side of the printer assembly. Paper should feed off the roll from the bottom (*not* over the top).



5. Feed the paper from the bottom of the paper roll through the opening in the top of the printer. Feed enough paper through so that it comes out the opening in the printer door. If the paper does not feed through, check to be sure the Run/Load lever is in the load position.



6. Pull a small amount of paper through the printer door, push the printer assembly in until the printer door release latches, and return the Run/Load lever to the run position. Press **Feed Paper** to be sure paper is feeding properly.

   Confirm that you have loaded the paper with the sensitized side towards the printer mechanism by printing a snapshot (press **Snapshot**).

Printing Reports
In addition to the reports and stripcharts that will print automatically, there are other reports and graphs that can be printed at user request.

Snapshots
Snapshots are instantaneous views of the power being monitored. Press the **Snapshot** button to print simultaneous voltage and current waveshapes, and environmental probe readings. Press Snapshot then Scroll Up arrow to print THD and harmonic spectrum (if Harmonic Option Package is installed).

Harmonics
When the Harmonic Option Package is installed, total harmonic distortion, and the harmonic spectrum will be printed by pressing **Snapshot** followed by the **Scroll Up** arrow.

Cancelling a Report or Graph
You can cancel a report or graph that is printing by pressing the **Cancel Printer** button. REPORT CANCELLED will appear across the partially printed report or graph.

To cancel all reports and graphs that the PowerScope has prepared or is currently preparing to print, press the **Cancel Printer** button followed by the **Scroll Up** arrow.

Setting Up Your PowerScope

The 8800 PowerScope with optional diskette drive

Using the Diskette Drive

Installed with the Storage Option Package
If your PowerScope is equipped with the Storage Option Package, a 3.5" diskette drive is installed above the printer assembly.

This diskette drive is a 720 kB, double-sided (DS), double-density (DD), IBM compatible MS DOS format drive. Diskettes can be initialized, written to, and read from your PowerScope. Any report, graph, or strip chart that prints can be stored to the diskette and played back through the printer.

Diskettes from your PowerScope can also be used in an IBM PC AT or compatible computer running PowerTalk View software. PowerTalk View software is a part of the Storage Option Package. Using PowerTalk View, you can view the graphs, output them to a local printer, and copy them into word processing documents.

Setting Up the Diskette Drive

Storage Menu
A Storage Menu will be added to the menus under the **Menu** button if the Storage Option Package is installed.

The Storage Menu allows you to set the status of the drive. Idle turns the drive off. Record sets the drive to record all information output by the PowerScope. Playback allows you to output one or all files on the diskette to the PowerScope printer. Initialize formats a new diskette for use in the drive.

The PowerScope printer can also be toggled on or off. If you are recording to diskette and do not want or need the paper printouts, you can turn the printer off. The PowerScope continues to monitor normally and saves all reports, graphs, and stripcharts to the diskette.

The Storage Menu is diagrammed in Chapter 5, Menu Layouts.

Idle
In idle mode, the PowerScope monitors normally but does not record anything to the diskette.

To set your PowerScope to idle, access the Storage Menu and use the **Scroll Down** arrow to position [MODE:] in the display window. Use the **Value Up/Value Down** buttons to change the mode to idle. Press the **Scroll Down** arrow. Your diskette drive is now off and will not record, initialize, or playback.

Record
Sets the diskette drive to record any output from the PowerScope to the diskette. Recording does not automatically disable the printer.

To record to a diskette, access the Storage Menu and use the **Scroll Down** arrow to position [Mode:] in the display window. Use the **Value Up/Value Down** buttons to change the mode to record, then press the **Scroll Down** arrow. Your PowerScope will now record to the diskette.

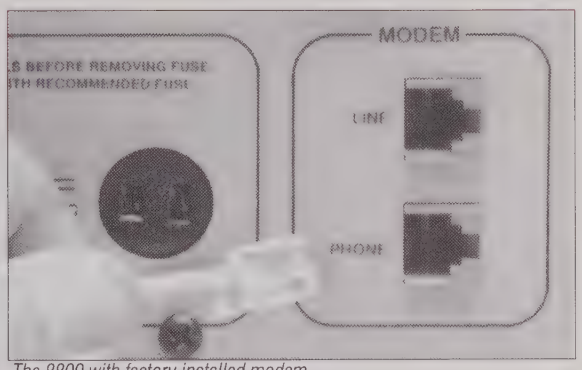
Playback
Allows you to playback the information recorded to the diskette using the PowerScope printer. Playback all files, selected files, or a file list.

To playback, access the Storage Menu and use the **Scroll Down** arrow to position [Mode:] in the display window.

Use the **Value Up/Value Down** buttons to change the mode to playback, then press the **Scroll Down** arrow. Once you have positioned [Playback:] in the window use the **Value Up/Value Down** buttons to select the desired output. Once your selection is positioned in the window press the **Scroll Down** arrow to print. When printing is complete, position [Playback: Quit] in the window and press the **Scroll Down** arrow. You will return to the top of the menu.

Initialize
Use this to format a new blank diskette for data storage, or to erase and reformat a data diskette.

To initialize a diskette, access the Storage Menu and use the **Scroll Down** arrow to position [Mode:] in the display window. Use the **Value Up/Value Down** buttons to change the mode to initialize, then press the **Scroll Down** arrow. Insert the diskette to be initialized into the drive and press the **Scroll Left** arrow. When completed, your diskette is ready to receive information.



The 8800 with factory installed modem

Using the Modem

Installed with the Communications Option Package
When you purchase the Communications Option Package an internal modem is installed in your PowerScope. This is an auto-dial, auto-answer, 300/1200/2400 baud modem. Connections are made through the RJ11 connectors on the back panel. The telephone line connects to the **Line** connector, and a line for a separate telephone set can be run from the **Phone** connector to the telephone.

To verify that a modem is installed and that your PowerScope recognizes it, press **Status** followed by the **Scroll Up** arrow to print a configuration report. Modem status will be included on the report.

Communication Menu
Set up your PowerScope to communicate with other PowerScopes through the Communication Menu. Your PowerScope can communicate via the standard RS-232 connector or via modem.

Access the Communication Menu by pressing the **Menus** button and use the **Value Up/Value Down** buttons to position [Menu: Communication] in the display window. Press the **Scroll Down** arrow to move into the menu selections.

Refer to Chapter 6, *Networking Your PowerScope*, and Chapter 5, *Communication Menu*, for more information on setting up communications.

Resetting and Clearing Accumulated Data

Resetting the PowerScope – "Soft" Reset
When you perform a soft reset of your PowerScope, you stop all activity within the PowerScope and return the unit to idle or the monitor mode (if you were in monitor when the reset was performed). Data previously collected into the memory is retained.

To "soft" reset:
1. Press **Cancel Printer** immediately followed by the **Scroll Up** arrow.

2. The PowerScope will go dark, all activity will cease, and the unit will restart. The printer will print a reset message that includes the time and date.

Resetting the PowerScope - "Hard" Reset
If you have tried a "soft" reset and the PowerScope did not clear, you may need to perform a "hard" reset.

To "hard" reset:
1. Push the printer door release to the right, and pull the printer assembly out until it stops.

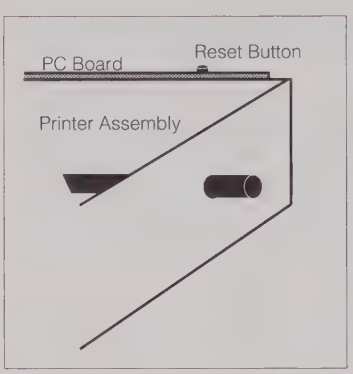
2. Press the black reset button located at the edge of the PC board behind the printer assembly (See **Figure 3.1**).

3. The PowerScope will go dark, all activity will cease, and the unit will restart. The printer will print a reset message that includes the time and date.

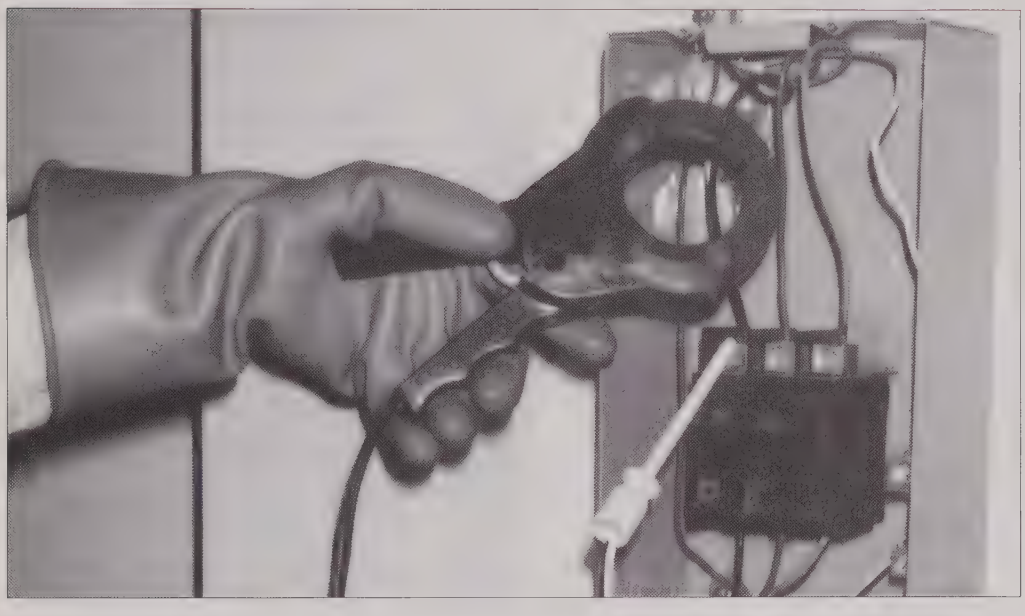
Resetting the PowerScope – Clearing Accumulated Data
Use this procedure when you need to reset your PowerScope to factory set default parameters.

To reset and clear accumulated data:
1. Press **Cancel Printer** followed by the **Scroll Up** arrow and then followed by the **Clear** button.

2. The unit will blank out and restart according to factory settings. All user entered information and any data in memory are now gone and the unit has reset to the factory specified defaults. The 8800 will print "The PowerScope is completely resetting its memory".

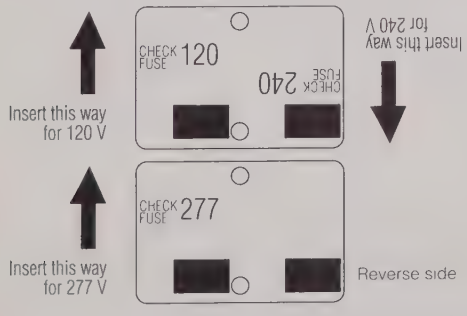


■ **Figure 3.1: Reset Button.**



Making Connections
This chapter will review and diagram all the connections for each power type. It also contains a checklist of cables and probes you'll need.

Verify Supply Voltage Setting
Make sure your PowerScope is correctly set for the supply voltage to be applied (see Voltage Supply PC Card Settings, page 2-4). The supply voltage is set with a small PC card positioned under the fuse holder on the back of the unit. Check that the PC card is positioned so that you can read your supply voltage when the card is inserted into the PowerScope. If the setting doesn't match your supply voltage, use needle-nose pliers to gently pull the PC card out and reinsert it so that the supply voltage is visible.


Insert this way for 120 V
CHECK FUSE 120
CHECK FUSE 240
Insert this way for 240 V
Insert this way for 277 V
CHECK FUSE 277
Reverse side

■ Figure 4.1: Supply Voltage PC Card. *Shown actual size*

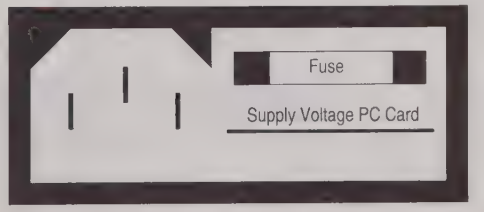
Set Your Power Type
Set your PowerScope to the power type you are going to monitor. To do this, press the **Menus** button and use the **Value Up/Value Down** buttons to position [Menu: Setup] in the display window. Use the **Scroll Down** arrow and position [Type:] in the window. Use the **Value Up/Value Down** buttons to select your power type.

Find the Number of Phases
Count the number of current carrying conductors, include the neutral conductor but not the ground/earth conductor:

One - Invalid. You must have more than one conductor.
Two - Single-phase
Three - Three-phase 3-wire, or split single-phase 3-wire
Four - Three-phase 4-wire
Five - You have counted wrong (do not count the ground/earth) or you have more than one power system.

WARNING! You are working with high voltages that cause burns and lethal shocks. Connect the safety (or earth) ground first. *Use standard safety precautions.*

■ Figure 4.2: Location of Supply Voltage PC Card.



4 Connecting to Power

Connect SmartProbes to Current Channel Inputs

Make sure SmartProbes correspond by phase to the voltage cables. Clamp the SmartProbes on conductors matching the direction of the power flow.

■ Figure 4.3: Match the direction of power flow with the SmartProbe

Check your voltage and SmartProbe connections. The table below cross-references wire coloration to phase. These color codes are often, but not always, followed. Use them only as a guide.

Location	Voltage	Phase A	Phase B	Phase C	Neutral	Earth
USA	120	black			white	green/bare
USA	120/208	black	red	blue	white	green/bare
USA	480	brown	orange	yellow		green/bare
USA	Distrib.	black	white	red		
Int'l	single-ph	brown			blue	grn/yellow
Int'l	3-phase	red	yellow	blue		grn/yellow

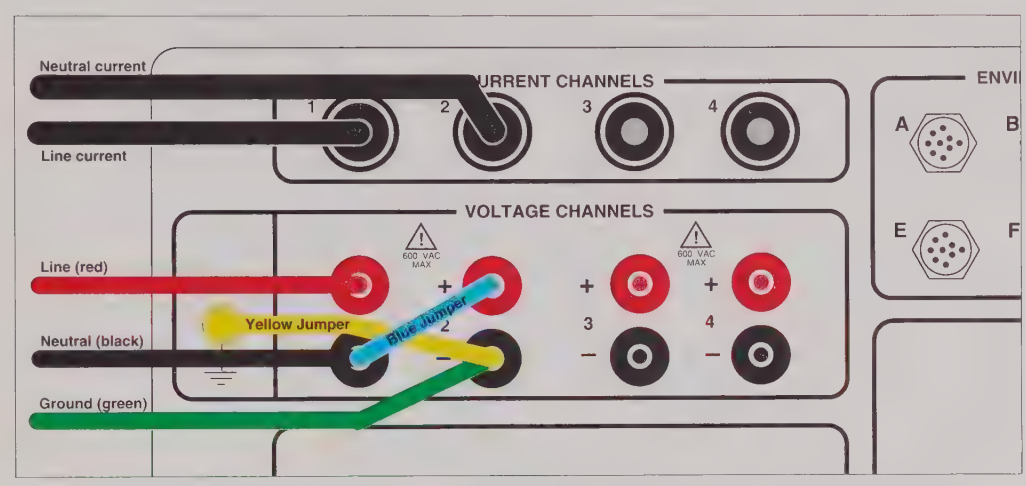
■ Table 4.1: Wire coloration to phase cross-reference

Checklist of Cables and Probes You Will Need

Power Type	Voltage	Current
Single-Phase	1 voltage measuring cable 1 yellow jumper cable with green ground plug 1 blue jumper **or . . .** 1 green ground cable 1 yellow jumper cable with green ground plug 1 red cable 1 black cable 1 blue jumper	2 SmartProbes
Dual Single Phase 3-wire	2 green ground cable 1 red cable 1 yellow cable 1 white cable 2 blue jumpers	3 SmartProbes
Three-Phase 3-wire Delta (Δ)	1 green ground cable 1 red cable 1 yellow cable 1 blue cable 3 blue jumpers	3 SmartProbes
Three-Phase 4-wire Wye (Y)	1 green ground cable 1 yellow jumper cable with green ground plug 1 red cable 1 yellow cable 1 blue cable 1 white cable 3 blue jumpers	4 SmartProbes

■ Table 4.2: Cable checklist

Single-Phase Connection



1. Connect line SmartProbe to current Channel 1 and neutral SmartProbe to current Channel 2.

2. Plug the green ground connector into the yellow jumper cable connector and plug these joined connectors into the Channel 2 black/negative socket. Plug the green ground plug on the yellow jumper cable into the green/ground socket on the PowerScope.

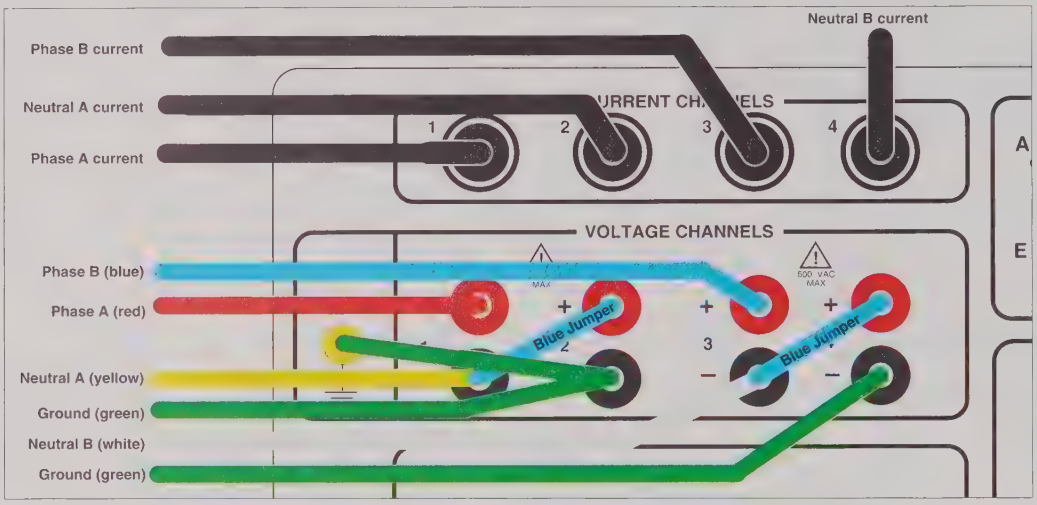
3. Connect the red cable to the Channel 1 red/positive socket.

4. Connect the black cable first into the blue jumper cable, then plug these joined connectors into the Channel 1 black/negative socket. Plug the other end of the blue jumper into the Channel 2 red/positive socket.

Connectors "piggy-back" for jumpered connections. Use to jumper one power system connection to a voltage input only. Never jumper two power system connections together (phase-to-phase or phase-to-neutral).

4 Connecting to Power

Dual Single-Phase Connection



1. Connect the Phase A SmartProbe to current Channel 1, the Neutral A SmartProbe to current Channel 2, the Phase B SmartProbe to current Channel 3, and the Neutral B SmartProbe to current Channel 4.

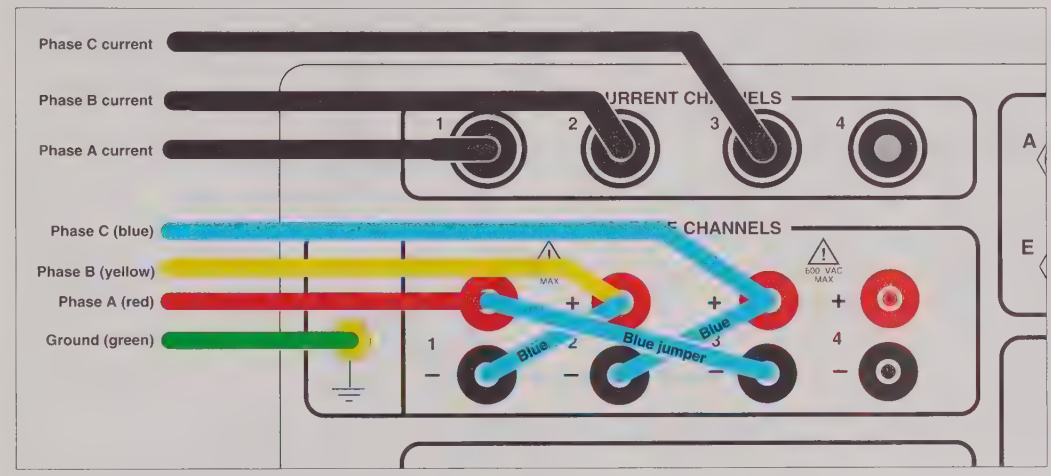
2. Plug the green ground connector into the yellow jumper cable connector and plug these joined connectors into the Channel 2 black/negative socket. Plug the green ground plug on the yellow jumper cable into the green ground socket on the PowerScope. Connect another green ground cable to voltage Channel 4 black/negative socket.

3. Connect Phase A red cable to voltage Channel 1 red/positive socket and the neutral A yellow cable first into a blue jumper and then plug these joined connectors into the voltage Channel 1 black/negative socket. Plug the loose end of the blue jumper into the voltage Channel 2 red/positive socket.

4. Connect Phase B blue cable to voltage Channel 3 red/positive socket and the neutral B white cable first into a blue jumper and then plug these joined connectors into the voltage Channel 3 black/negative socket. Plug the loose end of the blue jumper into the voltage Channel 4 red/positive socket.

Connectors "piggy-back" for jumpered connections. Use to jumper one power system connection to a voltage input only. Never jumper two power system connections together (phase-to-phase or phase-to-neutral).

Three-Phase Delta (Δ) Connection



1. Connect the Phase A SmartProbe to the current Channel 1 socket, the Phase B SmartProbe to the current Channel 2 socket and the Phase C SmartProbe to the current Channel 3 socket.

2. Plug the green ground connector into the green/ground socket on the PowerScope.

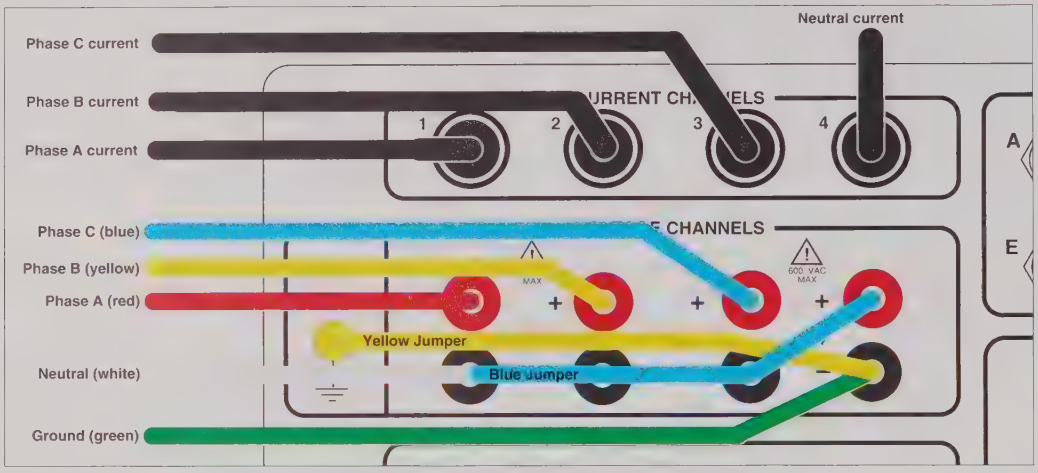
3. Connect the Phase A red cable to the Channel 1 red/positive connector, the Phase B yellow cable to the Channel 2 red/positive socket and the Phase C blue cable to the Channel 3 red/positive socket.

4. Using a blue jumper, connect Channel 1 red/positive to Channel 3 black/negative. Using a second blue jumper, connect Channel 2 red/positive to Channel 1 black/negative. Using your third blue jumper, connect Channel 3 red/positive to Channel 2 black/negative.

Connectors "piggy-back" for jumpered connections. Use to jumper one power system connection to a voltage input only. Never jumper two power system connections together (phase-to-phase or phase-to-neutral).

Connecting to Power

Three-Phase Wye (Y) Connection



1. Connect the Phase A SmartProbe to the current Channel 1 socket, the Phase B SmartProbe to the current Channel 2 socket, the Phase C SmartProbe to the current Channel 3 socket, and the Neutral SmartProbe to the Channel 4 current socket.

2. Plug the green ground connector into the yellow jumper cable connector and plug these joined connectors into the Channel 4 black/negative socket. Plug the green ground plug on the yellow jumper cable into the green/ground socket on the PowerScope.

3. Connect the Phase A red cable to the voltage Channel 1 red/positive socket, the Phase B yellow cable to the voltage Channel 2 red/positive socket, and the Phase C blue cable to the voltage Channel 3 red/positive socket.

4. Connect the white cable first into a blue jumper cable, then plug these joined connectors into the Channel 1 black/negative socket. Plug the other end of blue jumper into the Channel 2 black/negative socket. Connect another blue jumper to the Channel 2 black/negative socket and connect the loose end into the Channel 3 black/negative socket. Attach another blue jumper to the Channel 3 black/negative socket and connect the loose end to the Channel 4 red/positive.

Connectors "piggy-back" for jumpered connections. Use to jumper one power system connection to a voltage input only. Never jumper two power system connections together (phase-to-phase or phase-to-neutral).

Using the Menus

All the setup and operating information needed by your PowerScope to monitor power is entered or selected using a system of menus. These menus utilize the **Scroll Up/Scroll Down** arrows, **Value Up/Value Down** buttons, and alpha/numeric keypad for selecting and inputing information.

The following pages include step-by-step layouts of each menu.

Entering Information into Menu Selections

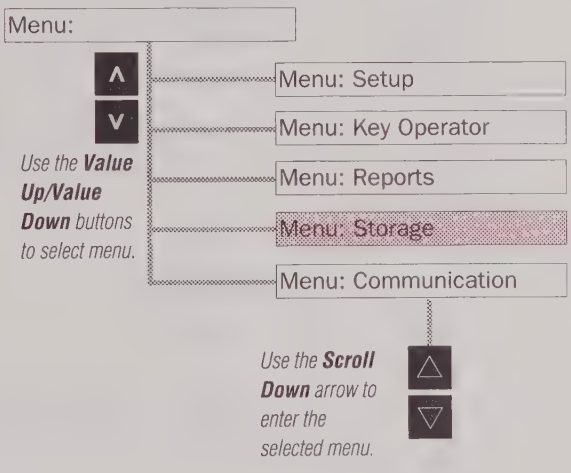
Data is entered into the menu selections using the **Scroll** arrows, **Value Up/Value Down** buttons, and the alpha/numeric keypad.

If the menu selection offers you preset choices, use the **Value Up/Value Down** button to select your choice by positioning it in the display window. Enter your selection by pressing the **Scroll Down** arrow. If the menu selection is set to cause your PowerScope to perform a function based on your response, pressing the **Scroll Down** arrow will activate that function (i.e., in the Communication Menu, positioning 'Hang Up Now' in the display window then pressing the **Scroll Down** arrow causes immediate termination of the connection).

Some menu selections allow you to enter text or values to meet your specific needs. Enter this data using the alpha/numeric keypad. For example, in the Setup Menu you want to enter your own site name (Bldg 1). At the menu selection [Site:], press the **2ABC** button three times (your first push will bring up a 2, the second will bring up an A, and the third will bring up a B). Press the **Scroll Right** arrow to move your blinking cursor to the second position. Press the **5JKL** button four times to position an L. Press the **Scroll Right** arrow. Enter the D by pressing the **3DEF** button twice. Press the **Scroll Right** arrow. Add the G by pressing the **4GHI** button twice. Press the **Scroll Right** arrow and make your fifth position blank by pressing the **Clear** button. Press the **Scroll Right** arrow. Now enter the 1 by pressing the **1** button once. Use the **Clear** button and the **Scroll Right** arrow to remove any additional letters remaining on the display after your site name. Your display should now read [Site: BLDG 1]. If you are satisfied with your site name, press the **Scroll Down** arrow to enter that name and move you to the next menu selection.

To Access the Menus

Press the **Menus** button.



Legend to Menu Symbols

Menu: Setup

Display window, standard menu selection

Menu: Storage

This menu or menu selection only appears if the corresponding Option Package is installed

Value Up/Value Down buttons
Use these to select a menu or enter information.

Scroll Up/Scroll Down arrows
Use these to move up and down through the menu selections.

Scroll Left/Scroll Right arrows
Use these to move the blinking cursor left and right in the menu selections.

Alpha/Numeric keypad
Use this to enter letters, numbers, and blank spaces. See the example in *Entering Information into Menu Selections.*

Menu Layouts

The Setup Menu

Press the Menus button once to access menu selection

Menu:

Menu: Setup

Site: ENTER

Type: SELECT

Type: Single Phase

Nom freq:

Freq tol:

Swell volt:[1]

Sag volt:

Amp mult:[2]

Swell amps:[3]

Sag amps:

Impulse thr:

Neut-Gnd: Voltage

Neut amp mult:[2]

Neut swell amp:[3]

Neut sag amp:

N-G imp thr:

Hi freq noise:

End of menu

Menu: Setup

Menu: Key Operator

Menu: Reports

Menu: Storage

Menu: Communication

Type: Single Phase — below, at left

Type: Dual 1 Phase — below, at right

Type: 3 Phase Delta — see page 5-3

Type: 3 Phase Wye — see page 5-3

Type: Ind Channels — see page 5-4

Use the Scroll Down arrow to move through menu selections

Shaded areas: Only appear if SmartProbes are installed

Selections will be added if probes are being used.

Type: Dual 1 Phase

Phase Setup: A

Nom freq:

Freq tol:

Swell volt:[1]

Sag volt:

Amp mult:[2]

Swell amps:[3]

Sag amps:

Impulse thr:

Neut-Gnd: Voltage

Neut amp mult:[2]

Neut swell amp:[3]

Neut sag amp:

N-G Imp thr:

Hi freq noise:

These selections repeated for Phase B setup.

End of menu

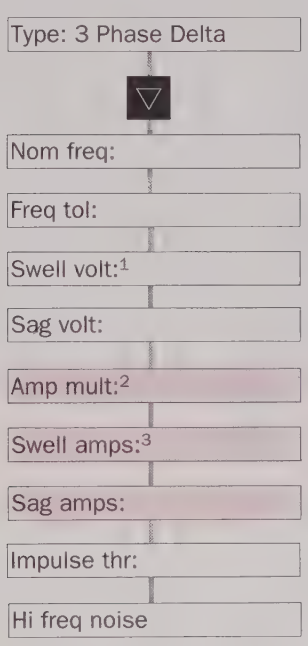
Use the **Scroll Up/Scroll Down** arrows to move between menu selections. The **Scroll Down** arrow enters the information in the menu selection.

Use the **Scroll Left/Scroll Right** arrows to move left and right within a menu selection (i.e., site name).

The **Value Up/Value Down** buttons are used to select from the preset information included in a menu selection.

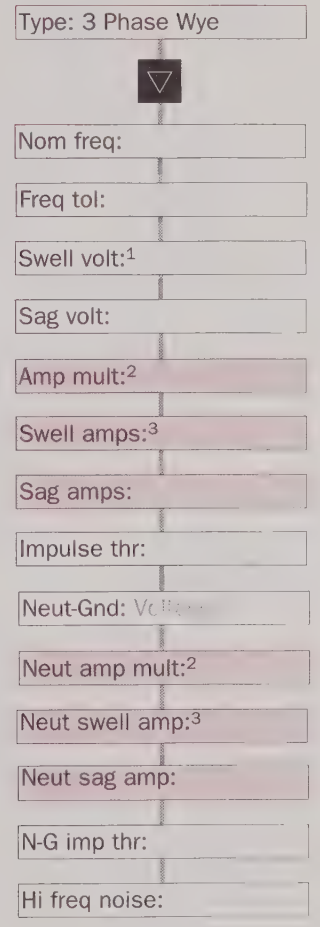
Use the alpha/numeric keypad to enter letters and numbers into menu selections.

The Setup Menu, continued . . .



Use the Scroll Down arrow to move through menu selections

Shaded areas: Only appear if SmartProbes are installed



1 The swell voltage threshold also determines the full scale RMS voltage as follows:

Swell Threshold	***Full Scale***
1.0 - 6.2 V_{rms}	*12 V_{rms}*
6.3 -12.5 V_{rms}	*25 V_{rms}*
12.6 - 25.0 V_{rms}	*50 V_{rms}*
25.1 - 62.5 V_{rms}	*125 V_{rms}*
62.6 - 125.0 V_{rms}	*250 V_{rms}*
125.1 - 166.5 V_{rms}	*333 V_{rms}*
166.6 - 250.0 V_{rms}	*500 V_{rms}*
≥ 250.1 V_{rms}	*1000 V_{rms}*

2 For use when connected to Current Transformers to ensure proper ratios. Range depends on SmartProbe as follows:

SmartProbe	***Multiplier range***
A-115	*0.0169 - 112.5*
A-115A	*0.0169 - 112.5*
A-116	*0.0016 - 12.5*
A-120	*0.0003 - 2.0*
A-121	*0.05 - 375.0*
A-705	*0.2222 - 750.0*
A-713	*0.0010 - 9.5*
A-721	*0.0512 - 300.0*
A-732	*0.0033 - 20.0*

3 Graph scaling is based on the current swell threshold, the multiplier and the SmartProbe used. As a general rule, for waveshape and snapshot graphs the full scale current is about 2.5 times the current swell threshold. For RMS current graphs the full scale value is roughly 1.5 times the current swell threshold.

Selections will be added if probes are being used.

Menu Layouts

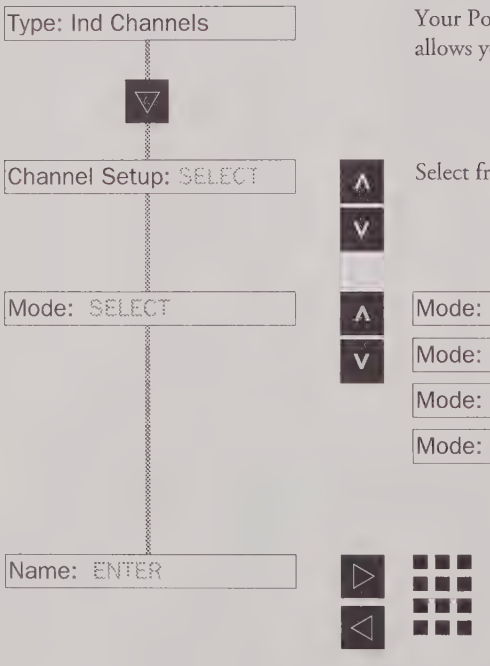
The Setup Menu, continued . . .

Use the **Scroll Up/Scroll Down** arrows to move between menu selections. The **Scroll Down** arrow enters the information in the menu selection.

Use the **Scroll Left/Scroll Right** arrows to move left and right within a menu selection (i.e.: site name).

The **Value Up/Value Down** buttons are used to select from the preset information included in a menu selection.

Use the alpha/numeric keypad to enter letters and numbers into menu selections



Your PowerScope can monitor on each channel independently of the others. This allows you to monitor multiple sources simultaneously and separately.

Select from 1, 2, 3, or 4

'Off' means you will not be using that channel

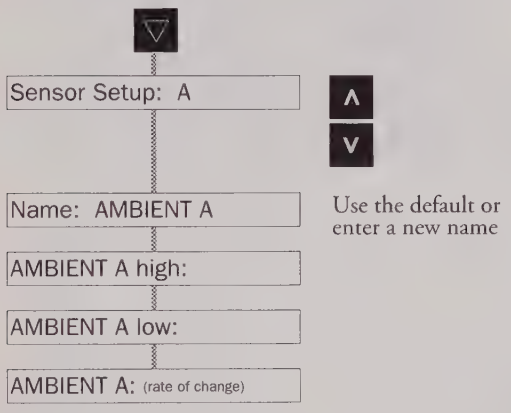
Menu selections will appear for the channel based upon the mode selected for the channel. Turning a channel to [mode: OFF] will eliminate any further menu selections for that channel. Menu selections will follow the format of the single-phase Setup Menu. See page 5-2 for single-phase menus.

Menu selections will be presented for each channel. After completing one channel, menu selections for the second channel will follow, and so on through four channels.

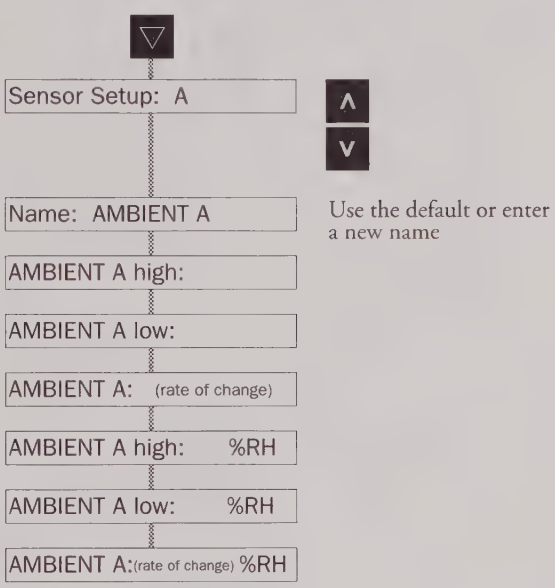
Menu Selections for Probes

When you have connected an optional probe to the environmental channels of your PowerScope, setup selections for the probe are added to the Setup Menu automatically. You can setup only those ports that have a probe attached to them. The port name (A through H) will be included in the menu selections. For layout purposes, we are assuming that the optional probe is connected to environmental port A in each of these menus.

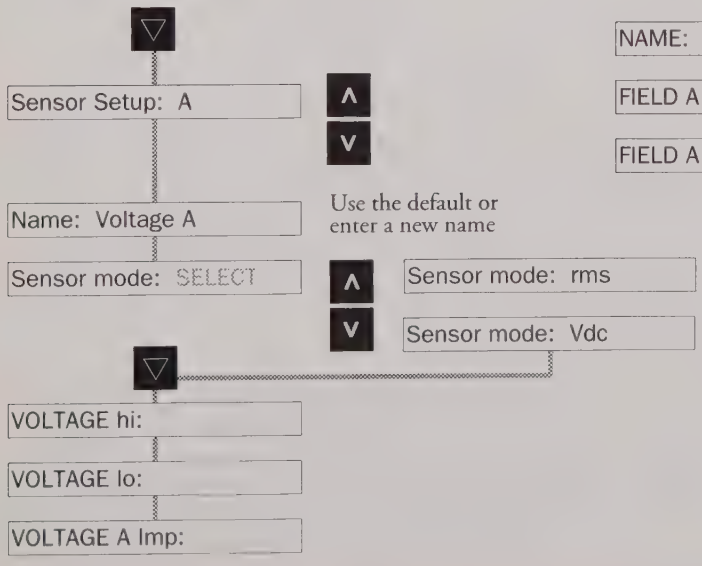
Temperature Probe



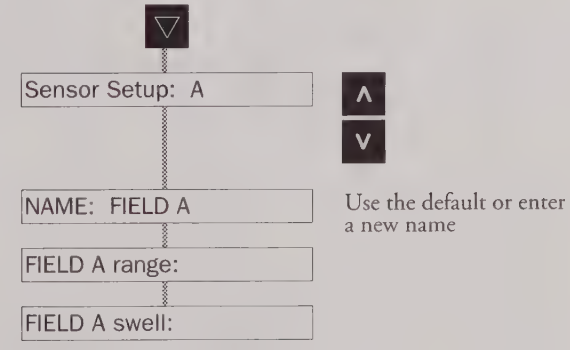
Temperature/Humidity Probe


Sensor Setup: A
Name: AMBIENT A
AMBIENT A high:
AMBIENT A low:
AMBIENT A: (rate of change)
AMBIENT A high: %RH
AMBIENT A low: %RH
AMBIENT A: (rate of change) %RH
Use the default or enter a new name

AC/DC/Impulse Probe



Radio Frequency Field Strength Probe



Menu Layouts

The Key Operator Menu

Press the Menus button once to access menu selection

Menu:

Menu: Setup

Menu: Key Operator

Menu: Reports

Menu: Storage

Menu: Communication

Menu: Key Operator

Use the Scroll Down arrow to move through menu selections

Wave shp:

Wave tolerance:

Hysteresis:[1]

Impulse rng:[2]

Line imp:[3]

Temp units:

Temp units: °C

Temp units: °F

Internal UPS:

Set the amount of time you want the internal NiCad batteries to maintain unit power during a power failure before shutting down (1 min. increments from 1 to 15 min.)

Current month:

Day of month:

Current year:

Date:

Date: U.S. Standard

Displays/prints date as Dec 2 1991

Date: EUR Standard

Displays/prints date as 2 Dec 1991

The Key Operator Menu continues on the next page

Use the **Scroll Up/Scroll Down** arrows to move between menu selections. The **Scroll Down** arrow enters the information in the menu selection.

Use the **Scroll Left/Scroll Right** arrows to move left and right within a menu selection (i.e.; site name).

The **Value Up/Value Down** buttons are used to select from the preset information included in a menu selection.

Use the alpha/numeric keypad to enter letters and numbers into menu selections

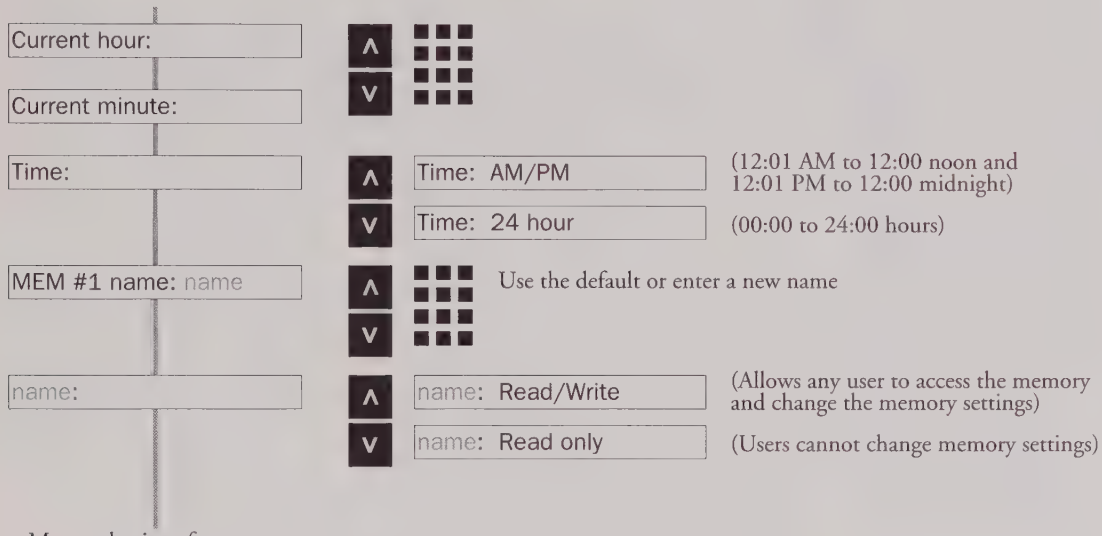
[1] *Use the number keys to enter the hysteresis as a percentage of fullscale.*

The acceptable range is 0.0% to 5.0%. A typical value is 1.0%

Hysteresis is an amount by which a threshold is altered in order to suppress disturbance graphs that would otherwise be triggered by small fluctuations in the measured signal.

If hysteresis is used, the threshold is altered by the specific percentage after an initial disturbance is triggered until the signal crosses the altered threshold. At this time, the threshold is restored to its original level. If you don't want hysteresis, enter 0.0% for the threshold.

The Key Operator Menu, continued . . .


Current hour:
Current minute:
Time:
Time: AM/PM
(12:01 AM to 12:00 noon and 12:01 PM to 12:00 midnight)
Time: 24 hour
(00:00 to 24:00 hours)
MEM #1 name: name
Use the default or enter a new name
name:
name: Read/Write
(Allows any user to access the memory and change the memory settings)
name: Read only
(Users cannot change memory settings)
Menu selections for memory are repeated for all 3 memories
End of menu

[2] If you choose automatic impulse ranging, your PowerScope automatically uses your impulse threshold to choose a full scale range.

If Impulse Threshold selected in previous question is between...	*The Impulse Range will set automatically to...*
20 - 50 volts	*+/– 100 volts*
51 - 100 volts	*+/– 200 volts*
101 - 200 volts	*+/– 400 volts*
201 - 400 volts	*+/– 800 volts*
401 - 800 volts	*+/– 1600 volts*
801 - 1600 volts	*+/– 3200 volts*
1601 - 6000 volts	*+/– 6400 volts*

However, if you choose manual impulse ranging, your PowerScope will ask you to choose a full-scale range. The choices offered you depend on the selected impulse threshold as follows:

Impulse Threshold	***Available Full-Scale Ranges***
20 - 24 Vpk	*+/– 100 or 200 volts full-scale*
24 - 49 Vpk	*+/– 100, 200 or 400 volts full-scale*
50 Vpk	*+/– 100, 200, 400 or 800 volts full-scale*
51-99 Vpk	*+/– 200, 400 or 800 volts full-scale*
100 Vpk	*+/– 200, 400, 800 or 1600 volts full-scale*
101 - 199 Vpk	*+/– 400, 800 or 1600 volts full-scale*
200 Vpk	*+/– 400, 800, 1600 or 3200 volts full-scale*
201 - 399 Vpk	*+/– 800, 1600 or 3200 volts full-scale*
400 Vpk	*+/– 800, 1600, 3200 or 6400 volts full-scale*
401 - 800 Vpk	*+/– 1600, 3200 or 6400 volts full-scale*

In applications where you know the size of impulses that disrupt equipment, it makes sense to choose automatic impulse ranging. In applications where you're trying to characterize a power line, it may make more sense to choose manual impulse ranging, then select the largest full-scale range available.

[3] Use the number keys to enter the estimated impedance of the power line at impulse frequencies.

The acceptable range is 1 ohm to 9,999 ohms. Fifty ohms is a reasonable value, unless you are measuring downstream from a power conditioner, where a value of a few hundred ohms is more typical.

The impedance is used in the calibration of approximate impulse energy. For a discussion of typical values, see J.H. Bull, "Impedance of the Mains Supply at Radio Frequencies", Proceedings of the 1st Symposium on EMC, MONTREAUX, 75CH1012-4, pp. 357-362, May 1975.

Menu Layouts

The Reports Menu, Single-Phase Set-ups

Press the Menus button once to access menu selection

Menu:

Menu: Setup

Menu: Key Operator

Menu: Reports

Menu: Storage

Menu: Communication

Menu: Reports

Use the Scroll Down arrow to move through menu selections

Strip charts:

Strip charts: 24Hr — Summary reports

Strip charts: 12Hr

Strip charts: 6Hr

Strip charts: 3Hr

Strip charts: 1Hr

Strip charts: Off

LINE Arms:

LINE-NEUT Vrms: Both

LINE-NEUT Vrms: 24Hr

LINE-NEUT Vrms: Graph

LINE-NEUT Vrms: Off

Both = text reports/graphs and 24 hour strip charts will print.

24HR = only 24 hour strip charts will print.

Graph/Text = only disturbance graph/report will print at threshold crossing.

LINE-NEUT Arms:

LINE Arms: Both

LINE Arms: 24Hr

LINE Arms: Graph

LINE Arms: Off

Off = no stripcharts, disturbance reports, or graphs will print. Data will be saved to memory for text printout on summary reports.

LINE-NEUT Imp:

LINE-NEUT Imp: Both

LINE-NEUT Imp: 24Hr

LINE-NEUT Imp: Graph

LINE-NEUT Imp: Off

LINE-NEUT HFN:

LINE-NEUT HFN: Both

LINE-NEUT HFN: 24Hr

LINE-NEUT HFN: Graph

LINE-NEUT HFN: Off

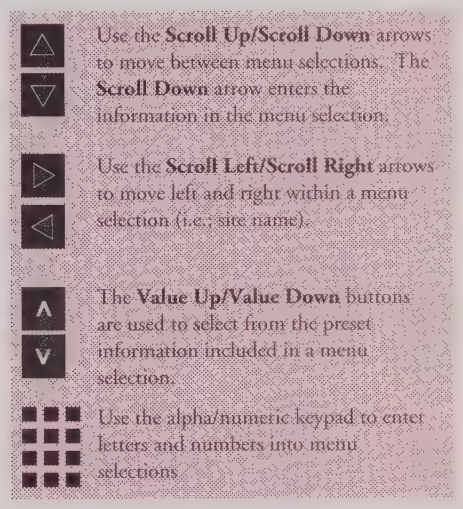
The Reports Menu is continued on the next page

The Reports Menu, Single-Phase Setups, continued . . .

- LINE-NEUT Freq:
  - ^ LINE-NEUT Freq: Both
  - v LINE-NEUT Freq: 24Hr
  - LINE-NEUT Freq: Text
  - LINE-NEUT Freq: Off
- LINE-NEUT Wave:
  - LINE-NEUT Wave: On
  - LINE-NEUT Wave: Off
- NEUT-GND Vrms:
  - NEUT-GND Vrms: Both
  - NEUT-GND Vrms: 24Hr
  - NEUT-GND Vrms: Graph
  - NEUT-GND Vrms: Off
- NEUT Arms:
  - NEUT-GND Arms: Both
  - NEUT-GND Arms: 24Hr
  - NEUT-GND Arms: Graph
  - NEUT-GND Arms: Off
- NEUT-GND Imp:
  - NEUT-GND Imp: Both
  - NEUT-GND Imp: 24Hr
  - NEUT-GND Imp: Graph
  - NEUT-GND Imp: Off
- NEUT-GND HFN:
  - NEUT-GND HFN: Both
  - NEUT-GND HFN: 24Hr
  - NEUT-GND HFN: Graph
  - NEUT-GND HFN: Off

Additional menu selections will be added if probes are being used

End of menu


Use the **Scroll Up/Scroll Down** arrows to move between menu selections. The **Scroll Down** arrow enters the information in the menu selection.
Use the **Scroll Left/Scroll Right** arrows to move left and right within a menu selection (i.e.; site name).
The **Value Up/Value Down** buttons are used to select from the preset information included in a menu selection.
Use the alpha/numeric keypad to enter letters and numbers into menu selections.

Both = text reports/graphs and 24 hour Strip charts will print.

24HR = only 24 hour Strip charts will print.

Graph/Text = only disturbance graph/ report will print at threshold crossing.

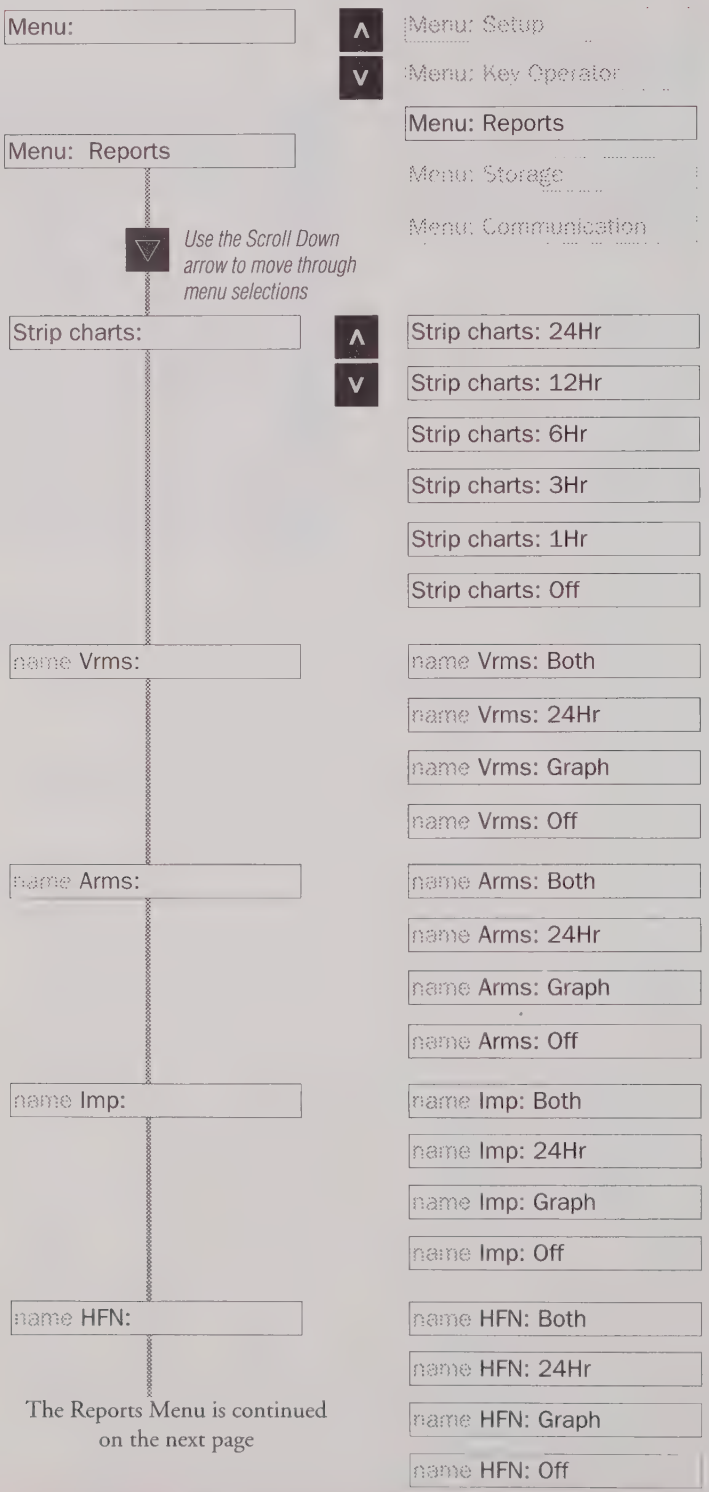
Off = no stripcharts, disturbance reports, or graphs will print. Data will be saved to memory for text printout on summary

Note: Line-neutral and neutral-ground menu selections will be presented twice in the dual single-phase report menu (first for Phase A and second for Phase B).

Menu Layouts

The Reports Menu, Three-Phase Set-ups

Press the Menus button once to access menu selection



The Reports Menu is continued on the next page

Use the **Scroll Up/Scroll Down** arrows to move between menu selections. The **Scroll Down** arrow enters the information in the menu selection.

Use the **Scroll Left/Scroll Right** arrows to move left and right within a menu selection (i.e.; site name).

The **Value Up/Value Down** buttons are used to select from the preset information included in a menu selection.

Use the alpha/numeric keypad to enter letters and numbers into menu selections

Both = text reports/graphs and 24 hour strip charts will print.

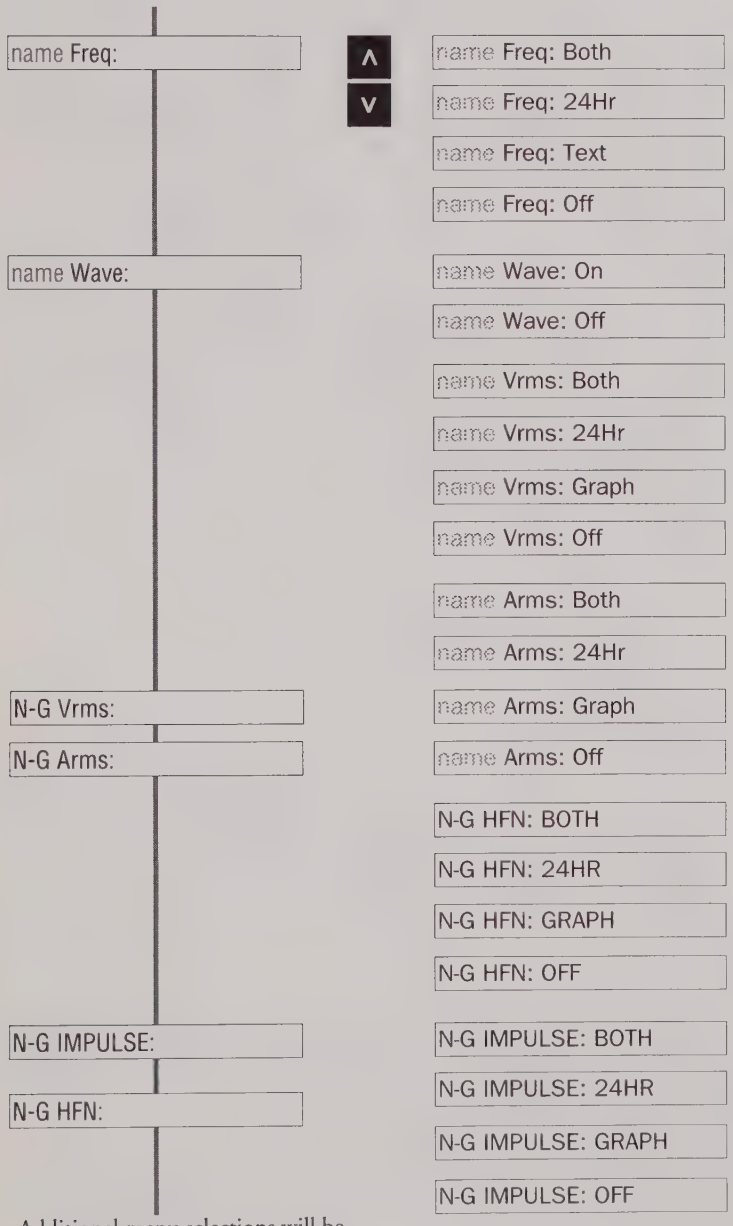
24HR = only 24 hour strip charts will print.

Graph/Text = only disturbance graph/ report will print at threshold crossing.

Off = no stripcharts, disturbance reports, or graphs will print. Data will be saved to memory for text printout on summary reports.

Note: RMS, HFN, frequency, and wave menu selections are repeated for Phase A-B, Phase B-C and Phase C-A in the Report Menu for three-phase delta. RMS, HFN, frequency, and wave menu selections are repeated for Phase A-N, Phase B-N, and Phase C-N for the Report Menu for three-phase wye. Neutral-ground selections given only in three-phase wye Report Menu.

The Reports Menu, Three-Phase Set-ups, continued . . .



Additional menu selections will be added if probes are being used

Use the **Scroll Up/Scroll Down** arrows to move between menu selections. The **Scroll Down** arrow enters the information in the menu selection.

Use the **Scroll Left/Scroll Right** arrows to move left and right within a menu selection (i.e.; site name).

The **Value Up/Value Down** buttons are used to select from the preset information included in a menu selection.

Use the alpha/numeric keypad to enter letters and numbers into menu selections.

Both = text reports/graphs and 24 hour Strip charts will print.

24HR = only 24 hour Strip charts will print.

Graph/Text = only disturbance graph/ report will print at threshold crossing.

Off = no stripcharts, disturbance reports, or graphs will print. Data will be saved to memory for text printout on summary reports.

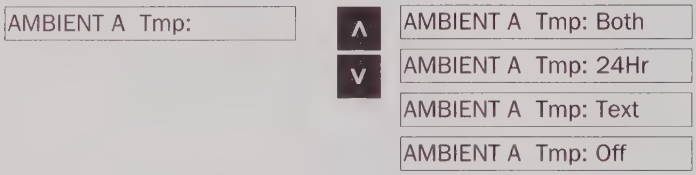
Note: RMS, HFN, frequency, and wave menu selections are repeated for Phase A-B, Phase B-C and Phase C-A in the Report Menu for three-phase delta. RMS, HFN, frequency, and wave menu selections are repeated for Phase A-N, Phase B-N, and Phase C-N for the Report Menu for three-phase wye. Neutral-ground selections given only in three-phase wye Report Menu.

Menu Layouts

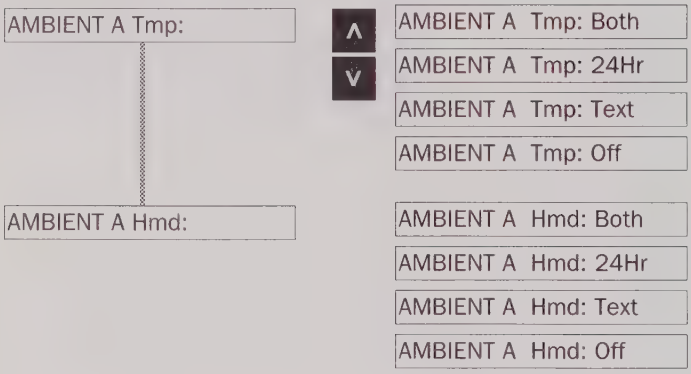
The Report Menu, continued . . .

Additional Probe Selections

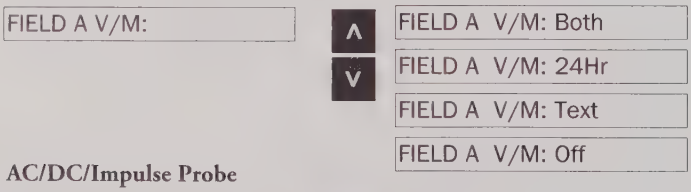
Temperature Probe



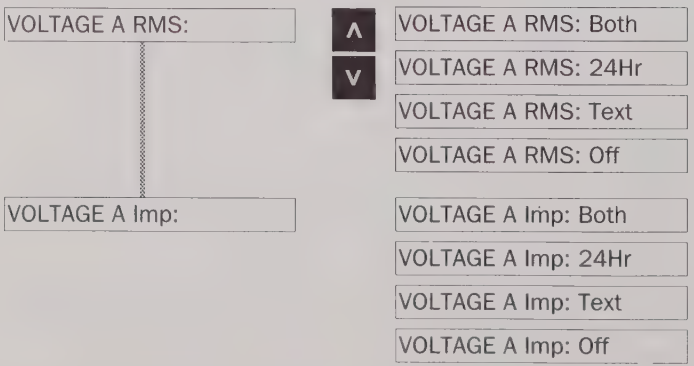
Temperature/Humidity Probe



Radio Frequency Field Strength Probe

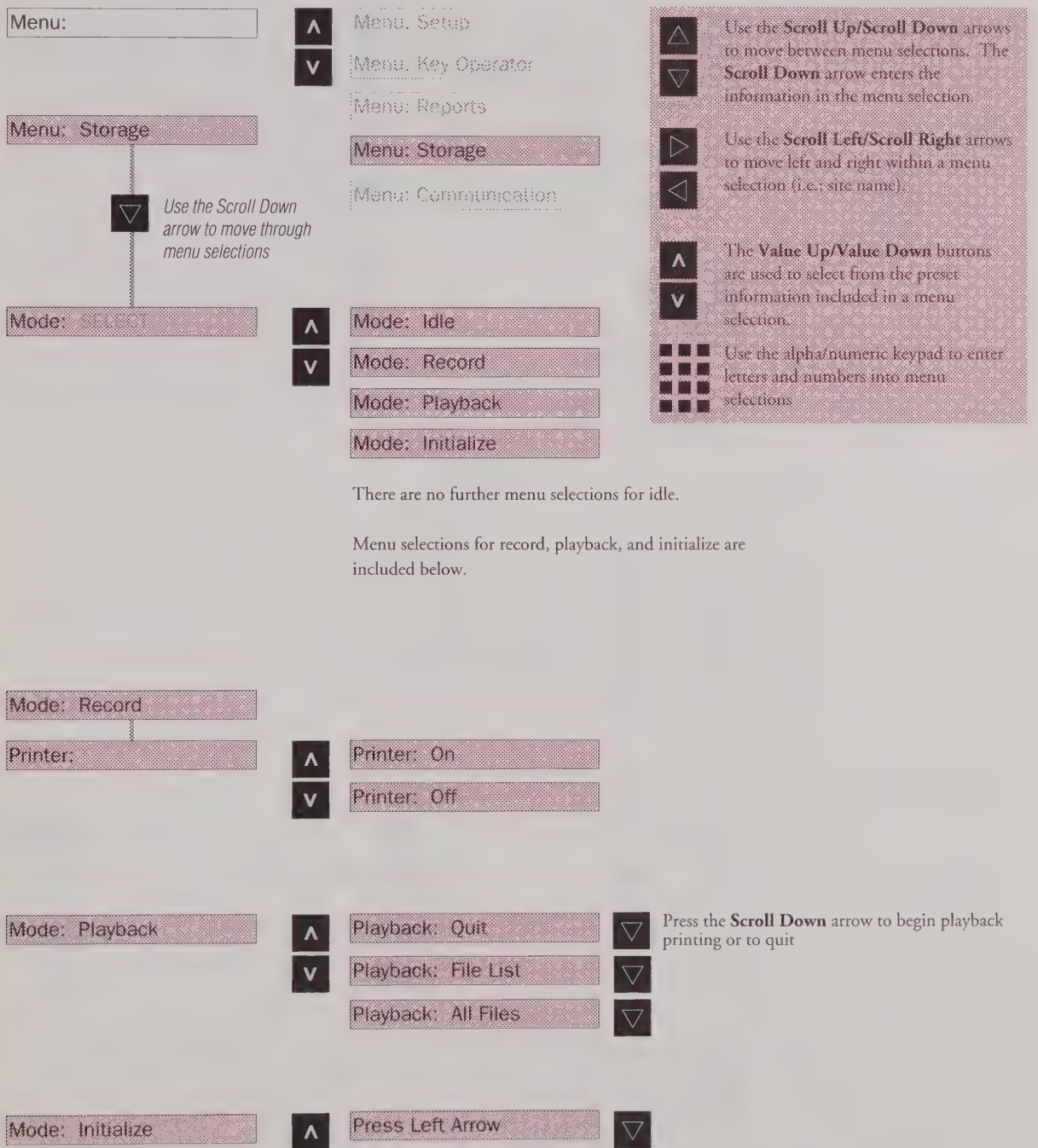


AC/DC/Impulse Probe



The Storage Menu

Press the Menus button once to access menu selection


Menu:
Menu: Setup
Menu: Key Operator
Menu: Reports
Menu: Storage
Menu: Communication
Menu: Storage
Use the Scroll Down arrow to move through menu selections
Mode: Select
Mode: Idle
Mode: Record
Mode: Playback
Mode: Initialize
Use the Scroll Up/Scroll Down arrows to move between menu selections. The Scroll Down arrow enters the information in the menu selection.
Use the Scroll Left/Scroll Right arrows to move left and right within a menu selection (i.e.; site name).
The Value Up/Value Down buttons are used to select from the preset information included in a menu selection.
Use the alpha/numeric keypad to enter letters and numbers into menu selections

There are no further menu selections for idle.

Menu selections for record, playback, and initialize are included below.

Menu Layouts

The Communication Menu

Press the Menus button once to access menu selection

Menu:

Menu: Communication

Port: SELECT

Port: RS-232

RS-232:

RS-232: Type

RS-232: Configuration

Baud rate:

Menu: Setup

Menu: Key Operator

Menu: Reports

Menu: Storage

Menu: Communication

Port: Off

Port: RS-232

Port: Internal Modem

Port: External Modem

Menu selections are the same for internal and external modem, see next page for layout.

Off disables all communications ports.

RS-232: Type

Type:

Type: Master

Type: Slave

Link RS-232 now: Yes/No

If you select Master, yes and **Scroll Down** arrow establishes connection via RS-232 port.

Slave Printer: On/Off

If you select Slave, on or off and **Scroll Down** arrow turns printer on or off.

RS-232: Configuration

Baud rate: 2400

Baud rate: 1200

Baud rate: 300

Use the **Scroll Up/Scroll Down** arrows to move between menu selections. The **Scroll Down** arrow enters the information in the menu selection.

Use the **Scroll Left/Scroll Right** arrows to move left and right within a menu selection (i.e.; site name).

The **Value Up/Value Down** buttons are used to select from the preset information included in a menu selection.

Use the alpha/numeric keypad to enter letters and numbers into menu selections

The Communication Menu, continued . . .

Modem Selections

Internal Modem
External Modem

Menu selections are the same for both modem types (internal modem menu is available only if internal modem is installed).

Modem:

- Modem: Tel numbers — Use alpha/numeric keypad to enter up to 8 names and phone numbers into directory
- Modem: Type — See menu selections below
- Modem: Configuration — See menu selections at bottom of page

Type:

- Type: Master
- Type: Slave

Connect to:

- Connecto to: Quit
- Connect to: Directory

To connect to a slave PowerScope, select name/number in directory, and press **Scroll Down** arrow to dial/connect.

Master:

- Master: Directory — Select master to connect to from directory
- Master: None

Slave printer:

- Slave printer: On
- Slave printer: Off

Hold line for::

Enter minutes to hold line before disconnect after data transmission

Check line now:

- Check line now: Yes
- Check line now: No

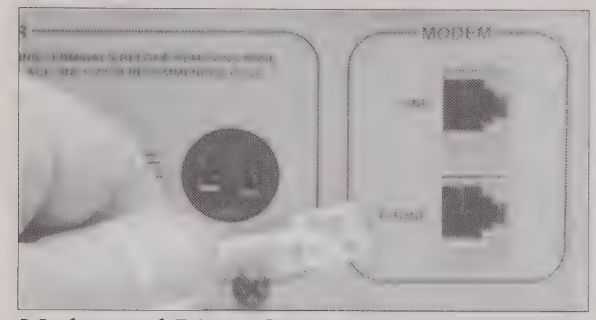
Select yes and press **Scroll Down** arrow to establish a test connection

Menu Layouts

The Communication Menu, continued . . .

- Configuration:
  - Baud rate:
    - Baud rate: 2400
    - Baud rate: 1200
    - Baud rate: 300
  - Dialing:
    - Dialing: Tone
    - Dialing: Pulsed
    - Dialing: Cabled
  - Answer tone:
    - Answer tone: Bell
    - Answer tone: CCITT
  - Carrier delay:

Use the alpha/numeric keypad to enter the desired carrier delay (entered in seconds).



Modem and Direct Connection

Multiple PowerScopes can be connected together to form a network. By setting up this network either via modem or RS-232, one PowerScope can become a central point for collecting information from other PowerScopes. The *Networking PowerScopes* section of this chapter will provide more detail on this capability.

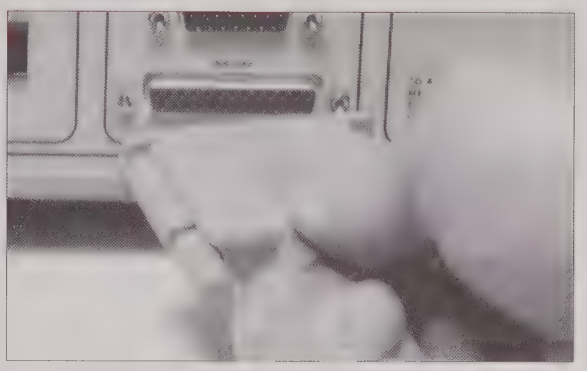
Frequently, PowerScopes must be placed in multiple locations where regular user contact is difficult or impossible. In these cases the PowerScope can communicate with the user via telephone lines.

The Communication Option Package places an internal auto-dial auto-answer modem into the PowerScope. RJ11 connectors are added to the rear panel to facilitate an incoming telephone line to the unit and a separate telephone set.

The internal modem can be added to your PowerScope at anytime. This is a return-to-factory installation. When ordering a new unit or upgrading an existing unit, specify the Communications Option Package.

An external modem may also be used. Connect the external modem to the RS-232 connector on the rear panel of the PowerScope. Specify in the communications menu that you are using an external modem, and the port type is RS-232.

Remember, the external modem must be Hayes SmartModem 2400 compatible.



Direct Connection via RS-232

Your PowerScope can be configured as a master and be connected to a remote slave PowerScope using the standard RS-232 connector on the back panel. Use an RS-232 cable to connect between the RS-232 connectors on each of your PowerScopes. Access the Communication Menu and set the port type to RS-232.

To setup master/slave communication via RS-232:

1. Press **Menus**. Use the **Value Up/Value Down** buttons to display the Communications Menu. To select, press **Scroll Down**.

2. Use the **Value Up/Value Down** buttons to display [Port: RS 232]. To select, press **Scroll Down**.

3. Decide if this PowerScope is the master or one of your slave units.

If it's one of the slaves...

1. Use the **Value Up/Value Down** buttons to display [RS 232: Type]. Press **Scroll Down**.

2. Use the **Value Up/Value Down** buttons to display [Type: Slave]. Press **Scroll Down**.

3. Use the **Value Up/Value Down** to turn the slave printer on or off. Press **Scroll Down** to select.

4. Use the **Scroll Up** arrow to display [RS 232: Configuration]. Press **Scroll Down**.

5. Use the **Value Up/Value Down** buttons to display the approprate baud rate. (Note: the baud rate for the master and slave units must be the same.) Press **Scroll Down** to enter.

6 Networking Your PowerScope

If it's the master...

1. Use the **Scroll Up/Scroll Down** keys to display [RS 232: Configuration]. Press **Scroll Down**.

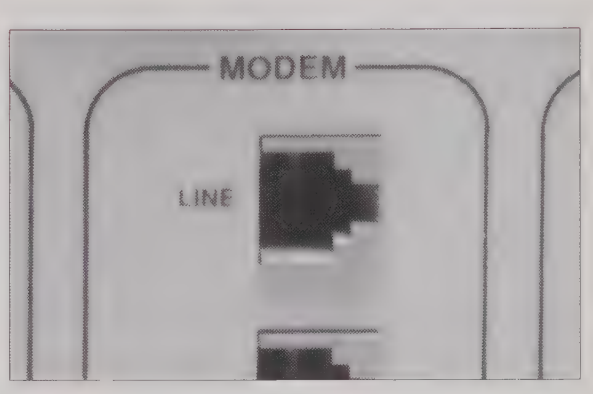
2. Use the **Value Up/Value Down** buttons to display desired baud rate. Press **Scroll Down** arrow to select.

3. Press the **Scroll Up** arrow to display [RS 232:]. Use the **Value Up/Value Down** buttons to display [RS 232 Type:]. Press **Scroll Down**.

4. Press **Value Up/Value Down** buttons to display [Type: Master]. Press **Scroll Down** arrow to select.

5. Use **Value Up/Value Down** buttons to display [Link RS 232 now: Yes]. Press **Scroll Down** to initiate the connection. The display will indicate if a connection is made.

6. After establishing your connection, press **Monitor** to begin monitoring disturbances with the slave unit.



Networking PowerScopes

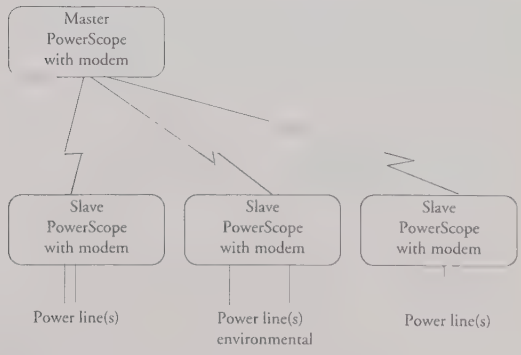
Using a Modem

The modem allows you to form a PowerScope network. Each network has one master PowerScope and one or more slave PowerScopes. Every PowerScope in the network must have a modem (internal or external).

The slave PowerScopes monitor power and environmental disturbances, and report the disturbances to the master PowerScope.

The master PowerScope prints the disturbances, and controls all aspects of the slave PowerScopes, including their Setup and Report Menus.

Typically, you'll keep the master PowerScope on your desk and you'll have several slave PowerScopes at monitoring sites in the field.



■ **Figure 6.1: Typical PowerScope network**

To Setup a PowerScope Network

1. Press **Menus**. Use the **Value Up/Value Down** buttons to select the Communication Menu.

2. Use the **Scroll Down** arrow to select [Port]. Use the **Value Up/Value Down** buttons to select either internal or external modem.

3. Press the **Scroll Down** arrow to select [Modem:]. Use the **Value Up/Value Down** buttons to select [Modem: Tel Numbers].

4. Use the alpha/numeric keypad to enter the names and phone numbers of all the PowerScopes in your network (up to 8 maximum).

5. Decide if this PowerScope is the master or one of your slave PowerScopes.

If it's the master . . .

1. Scroll back to [Modem: Tel Numbers]. Use the **Value Up/Value Down** buttons to select [Modem: Type].

2. Press the**Scroll Down** arrow to select [Type:] and use the **Value Up/Value Down** buttons to select [Type: Master].

3. Press the **Scroll Down** arrow to select [Connect To:]. Use the **Value Up/Value Down** buttons to select the slave PowerScope you want to connect to. Press the **Scroll Down** arrow and your Master PowerScope will call the selected slave PowerScope. The Master's keyboard, printer, and display will take over the slave's keyboard, printer, and display. If you choose [Connect To: Quit] instead of a slave PowerScope, your master PowerScope will wait for a slave PowerScope to call.

If it's one of the slave PowerScopes . . .

1. Scroll back to [Modem: Tel Numbers]. Use the **Value Up/Value Down** buttons to select [Modem: Type].

2. Press the **Scroll Down** arrow to select [Type:] and use the**Value Up/Value Down** buttons to select [Type: Slave]. Press the **Scroll Down** arrow to select [Master:].

3. Use the **Value Up/Value Down** buttons to select the master PowerScope you want to connect to. Press the **Scroll Down** arrow and your slave PowerScope will call the selected master PowerScope.

4. Use the **Scroll Down** arrow to select [Slave pinter:]. Use the **Value Up/Value Down** buttons to turn the slave printer on or off.

5. Press the **Scroll Down** arrow to move to [Hold Line For:]. Enter the number of minutes you want the slave to hold the line for after transmitting data (we recommend 2 minutes).

6. Press the **Scroll Down** arrow to select [Check Line Now:]. Use the **Value Up/Value Down** buttons to select yes if you want to check your connection. Press the **Scroll Down** arrow to initiate the check.

   While trying to establish a connections, the display will read [Dialing....]. If no connection is made, the display will change to [No dial tone].

7. After establishing your connection, press **Monitor** then **Lock** to lock the keyboard and transmit all disturbances to the master PowerScope.

To configure the modem:

1. Press **Menus**. Use the **Value Up/Value Down** buttons to select the Communications Menu.

2. Use the **Scroll Down** arrow to select [Modem:]. use the **Value Up/Value Down** buttons to select [Modem: Configuration].

3. Use the **Value Up/Value Down** buttons to select 300, 1200, or 2400 baud rate.

4. Use the **Scroll Down** arrow to move between dialing, answer tone, and carrier delay selections.

5. Use the **Value Up/Value Down** buttons and alpha/numeric keypad to enter your choices.

6 Networking Your PowerScope

Minimum PC Configuration Requirements

MS-DOS based 286, 386 or 486 PC

2 Mb memory minimum
(4 Mb extended memory recommended)

20 Mb hard disk minimum
(larger recommended)

VGA graphics

Microsoft Windows
(version 3.0 or higher)

Mouse (bus-type recommended)

PowerTalk Software

BMI's PowerTalk software consists of PowerTalk View and PowerTalk Control. PowerTalk View software is shipped as a standard part of the PowerScope Storage Option Package. PowerTalk Control can be purchased separately. Consult your PowerTalk User's Guide for detailed instructions about the software.

PowerTalk Software and Hardware Requirements

PowerTalk is designed for use with Microsoft Windows 3.0 and higher. Operation or any other version of Microsoft Windows is not guaranteed nor supported. Please consult your Microsoft Windows manual for proper installation instructions.

The hardware requirements are:

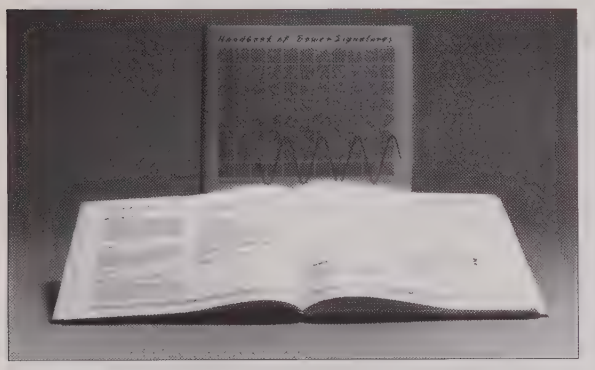
- DOS compatible 286, 386, or 486 PC preferred
- 2 MByte RAM minimum; 4 MByte recommended
- 20 MByte minimum hard drive
- Mouse recommended but not required
- VGA graphics monitor, color or monochrome

PowerTalk View

With PowerTalk View you can use your PC to look at data stored on diskette. Use your computer to select files and disturbance types, review and print specific files, or cut and paste disturbances or files for use in word processing packages. You can also convert graphs to TIFF graphics files.

PowerTalk Control

PowerTalk Control software, available from BMI, enables you to control an entire network of BMI PowerScopes (and PowerProfilers) right from your desk. Front panel simulation of the instrument allows you to use the mouse to "push" buttons just as you would sitting in front of the instrument.



The *Handbook of Power Signatures*

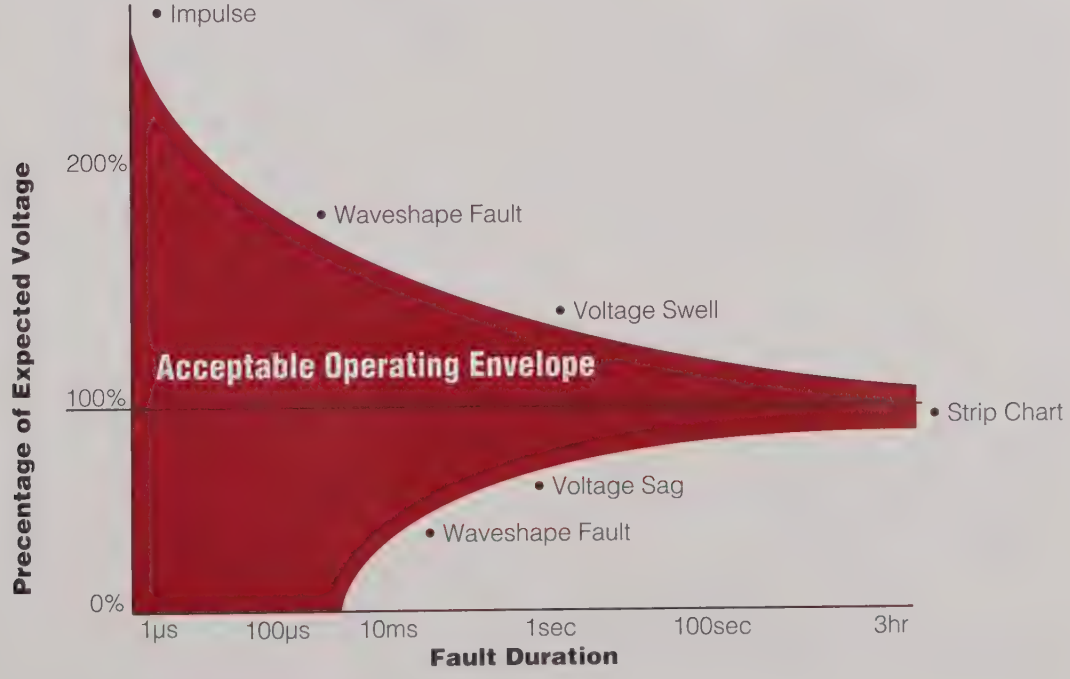
To determine the cause and solution to power problems, find close matches to your disturbance graphs in the *Handbook of Power Signatures.* Published as a companion to the PowerScope, the *Handbook* provides over 100 examples of the most common power problems. Included with each graph are the identifying features, the cause , symptoms, and solutions. The *Handbook* also tells you about other graphs that are related to or that contrast with the problem.

Electronic Operating Envelope

Electronic equipment will function successfully when the available power falls within a defined operating envelope. As illustrated by the graph below, the amplitude and duration of disturbances are the characteristics that determine if power falls outside of the envelope.

To formulate a complete diagnosis of power quality, a power monitor must detect all disruptive disturbances. These include impulses, waveshape faults, and voltage sags and swells, but in addition, frequency errors, high-frequency noise, radio-frequency interference, and temperature and humidity fluctuations should be considered as possible causes of operating problems.

When these disturbances are graphed, they can be analyzed, traced to their source, and solved.



Reports and Graphs

How to Read Waveshape Graphs

Waveshape graphs get printed whenever you press the **Snapshot** button, or whenever you request a harmonics analysis (**Snapshot** followed by **Scroll Up**), and whenever the general shape of the voltage waveform changes

An 8800 PowerScope compares every cycle of the voltage waveform with the previous cycle. If the new cycle differs from the previous cycle by more than a threshold amount, a voltage waveshape fault graph is triggered. These graphs may show a brief disturbance, or they may come in pairs with one graph showing the change away from normal and the other showing the change back.

Voltages are shown as black lines; currents are shown as gray lines.

Parts of the Waveshape Graph

1 Site name. Defaults to "BMI 8800 Site" or can be changed by the user in the Setup Menu.

2 Channel name. The PowerScope will automatically select a channel name if you choose one of the standard power types (single-phase, three-phase delta, etc.), or the user can enter one of their own choice in the Setup Menu.

3 Date and time. This is the date and time the disturbance was recorded. Time in the upper right is shown to a resolution of .01 seconds. Waveshape and impulse events which show times here within .03 seconds of each other should usually be treated as though they occurred simultaneously. When relating waveshapes to sags and swells, treat events that occur within 0.2 seconds of each other as simultaneous events due to the time constant of the true-RMS converters.

4 Type of triggering. Either snapshot or waveshape fault (voltage).

5 Vertical voltage scale. Each vertical voltage division is shown by tick marks along the left border, and by individual dots in the graph area. The vertical axis is differential voltage between the red and black input terminals on voltage graphs.

6 Full scale value. This value is automatically selected based on the surge threshold you selected, and is rounded to the nearest integer. If there is a rounding conflict between this value and the vertical scale, rely on the vertical scale.

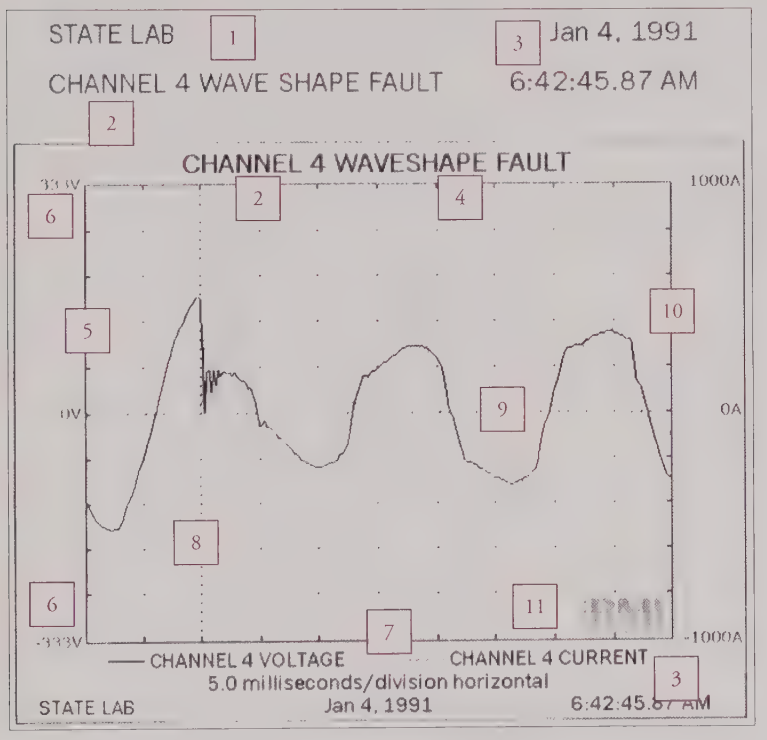
7 Horizontal scale, 5.0 ms per division. Each horizontal division is shown by tick marks along the top and bottom borders, and by individual dots in the graph area.

8 Trigger line. The point in time when the PowerScope determined that a waveshape fault occurred. Points to the left of this line are pretrigger data; points to the right are post-trigger data. Some graphs have no trigger line since they are triggered by the user either by pressing **Snapshot** or by pressing **Snapshot** and **Scroll Up** to request harmonic and spectrum analysis.

9 Zero line. The horizontal axis is the zero reference line (representing zero volts difference between red and black input terminals and zero amps current for current probes).

10 Vertical current scale. Each vertical current division is shown by tick marks along the right border and by individual dots in the graph area.

11 Additional faults counter. If additional waveshape faults occurred subsequent to the one shown, and there was no room in the buffering system for them, they are counted and presented here.


STATE LAB
1
3
Jan 4, 1991
CHANNEL 4 WAVE SHAPE FAULT
6:42:45.87 AM
2
CHANNEL 4 WAVESHAPE FAULT
1000A
6
2
4
10
5
0V
9
0A
8
6
11
7
-1000A
CHANNEL 4 VOLTAGE
CHANNEL 4 CURRENT
5.0 milliseconds/division horizontal
3
STATE LAB
Jan 4, 1991
6:42:45.87 AM

7 Reports and Graphs

How to Read Impulse Graphs

Impulse graphs are printed whenever the voltage on a channel, examined through a high-pass filter, exceeds the impulse threshold voltage that you choose.

The lower graph shows what happened to the sine wave before and after the impulse occurred. The upper graph zooms in on the impulse itself, as seen through a high-pass filter; the zero-line is the expected value of the sine wave at that point.

Impulse disturbance graphs cover a time scale from 64µs to one millisecond (ms). You can also use your PowerScope to print impulse strip charts for each channel that are 1, 3, 6, 12, or 24 hours long. Voltages are shown with black lines; currents are shown as gray lines.

Parts of the Impulse Graph

1 Site name. Defaults to "BMI 8800 Site" or can be changed by the user in the Setup Menu.

2 Channel name. The PowerScope will automatically select a channel name if you choose one of the standard power types (single-phase, three-phase delta, etc.), or the user can enter one of their own choice in the Setup Menu.

3 Date and time. This is the date and time the disturbance was recorded. Time in the upper right is shown to a resolution of .01 seconds. Waveshape and impulse events which show times here within .03 seconds of each other should usually be treated as though they occurred simultaneously. When relating waveshapes to sags and swells, treat events that occur within 0.2 seconds of each other as simultaneous events due to the time constant of the true-RMS converters.

4 Peak impulse voltage. The absolute value of the highest voltage the impulse reached, which is not necessarily the peak immediately after crossing the threshold. If a ">" (greater than) symbol appears in front of the value, the impulse went off-scale on the display.

5 Impulse phase position. The point on the sine wave where the impulse appeared, with 0° being the positive-going zero-crossing, 90° being the positive peak of the sine wave, 180° being the negative-going zero-crossing, and 270° being the negative peak of the sine wave. If the PowerScope cannot calculate the phase position (for example, when monitoring DC), the words "no phase position" are printed here.

6 Impulse rise time. The approximate rise time of the threshold-crossing segment of the impulse.

7 Impulse energy. The approximate energy of the impulse. This calculated value assumes the resistive impedance shown in parentheses, which can be adjusted in the Key Operator Menu using the formula shown here where E is the instantaneous voltage, Z is the impedance, and the integration is performed by parts over the interval displayed in the upper graph. The energy may be shown in microJoules, milliJoules, Joules, or kiloJoules; if there are doubts about the calculation, a question mark is placed in front of the units.

$$\int \frac{E^2}{Z}\,dt$$

8 Full scale, upper graph. This value may have been automatically selected based on the impulse threshold you chose, or, if you chose manual impulse ranging in the Key Operator Menu, you may have selected this value from several available values.

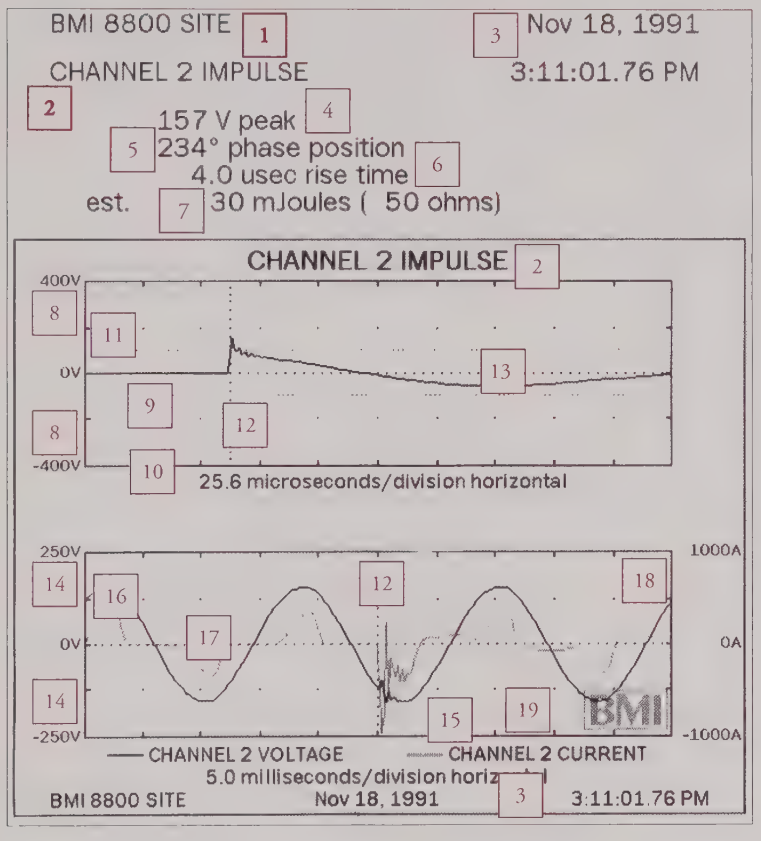
9 Impulse threshold lines. Dashed lines indicating the impulse threshold that you selected.

10 Horizontal Scale, upper graph. The scale is automatically selected and is the best compromise between maximum resolution and complete data after capturing the impulse. Each division is shown by tick marks along the top and bottom borders, and by dots in the graph area.

11 Vertical scale, upper graph. Each voltage division is shown by tick marks along the left and right border, and by dots in the graph area. The division marks may be hidden by the impulse threshold lines (9).

12 Trigger lines. The point in time when the PowerScope determined that an impulse occurred. Points to the left of this line are pre-trigger data, and points to the right are post-trigger data. The two trigger lines are at the same instant in time.

13 Upper graph zero line. Effectively, the expected value of the sine wave.



14 Full scale, lower graph. This value was automatically selected based on the surge threshold you chose.

15 Horizontal scale, lower graph, 5.0 ms per division. Each division is shown by tick marks along the top and bottom borders, and dots in the graph area.

16 Vertical voltage scale, lower graph. Each division is shown by tick marks along the left border of the graph, and by dots in the graph area.

17 Lower graph zero line. The horizontal axis of the waveshape is the differential voltage between the red and black input terminals on voltage graphs.

18 Vertical current scale, lower graph. Each vertical current division is shown by tick marks along the right border and by individual dots in the graph area.

19 Additional impulse counter. If additional impulses occurred subsequent to the ones shown, and there was no room in the buffering system for them, they are counted and presented here.

Reports and Graphs

How to Read Swell/Sag Graphs

Swell or sag graphs are printed whenever the true RMS voltage (or current) on a channel exceeds the swell or sag threshold that you chose. If the swell or sag continues for longer than 16 seconds, a "swell ended" or "sag ended" graph is printed when the true RMS voltage (or current) comes back within the thresholds that you chose.

PowerScope swell and sag thresholds have programmable hysteresis, or "snap action."

Swell and sag disturbance graphs are 20 seconds long. You can print RMS voltage strip charts for each channel that are 1, 3, 6, 12, or 24 hours long.

Voltages are shown in black; currents are shown in gray.

Parts of the Swell/Sag Graph

1 Site name. Defaults to "BMI 8800 Site" or can be changed by the user in the Setup Menu.

2 Channel name. The PowerScope will automatically select a channel name if you choose one of the standard power types (single-phase, three-phase delta, etc.), or the user can enter one of their own choice in the Setup Menu.

3 Date and time. This is the date and time the disturbance was recorded. Time in the upper right is shown to a resolution of .01 seconds. Waveshape and impulse events which show times here within .03 seconds of each other should usually be treated as though they occurred simultaneously. When relating waveshapes to sags and swells, treat events that occur within 0.2 seconds of each other as simultaneous events due to the time constant of the true-RMS converters.

4 Trigger. There are several phrases that can appear here:

SAG - The true RMS signal was below the sag threshold (8) at the trigger line (9). If the voltage returns to between the sag and the swell thresholds before the end of the graph, the entire disturbance will be visible on the SAG graph and a SAG ENDED graph will not be printed.

SWELL - The true RMS signal was above the swell threshold (8) at the trigger line (9). If the voltage returns to between the sag and the swell thresholds before the end of the graph, the entire disturbance will be visible on the SWELL graph and a SWELL ENDED graph will not be printed.

SAG/SWELL - the true RMS signal went both above the swell threshold and below the sag threshold.

SAG ENDED - the true RMS signal was below the sag threshold at the left edge of the graph and between the thresholds at the right edge. It crossed the sag threshold for the first time at the trigger line (9).

SWELL ENDED - The true RMS signal was above the swell threshold at the left edge of the graph and between the thresholds at the right edge. It crossed the swell threshold for the first time at the trigger line (9).

5 Minimum and/or maximum voltage (or current). The minimum true RMS voltage of the sag, or the maximum true RMS voltage of the swell, or both if the voltage went both below the sag threshold and above the swell threshold.

6 Duration. The total length of time the voltage was outside the threshold.

7 Vertical voltage full scale. This value is automatically selected based on the swell voltage threshold you chose.

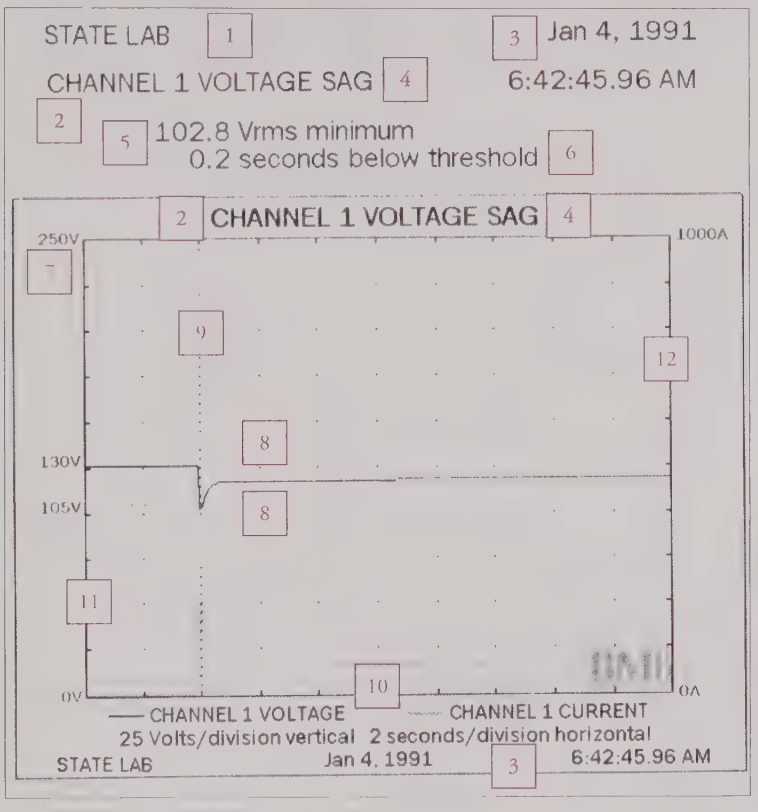
8 Swell/sag threshold lines. Dashed lines indicating the swell and sag thresholds that you selected.

9 Trigger line. The point in time when the PowerScope determined that a swell or a sag occurred. Points to the left of this line are 4 seconds of pre-trigger data; points to the right are 16 seconds of post-trigger data.

10 Horizontal scale. Typically 2 seconds per division. Each division is shown by tick marks along the top and bottom borders, and by dots in the graph area.

11 Vertical voltage scale. Each vertical division is shown by tick marks along the left border, and by dots in the graph area.

12 Vertical current scale. Each vertical current division is shown by tick marks along the right border and by individual dots in the graph area.


STATE LAB
1
3
Jan 4, 1991
CHANNEL 1 VOLTAGE SAG
4
6:42:45.96 AM
2
5
102.8 Vrms minimum
0.2 seconds below threshold
6
2
CHANNEL 1 VOLTAGE SAG
4
250V
1000A
7
9
12
8
130V
105V
8
11
10
0V
0A
CHANNEL 1 VOLTAGE
CHANNEL 1 CURRENT
25 Volts/division vertical
2 seconds/division horizontal
STATE LAB
Jan 4, 1991
3
6:42:45.96 AM

Reports and Graphs

How to Read High Frequency Noise Surge Graphs
High frequency noise (HFN) is on-going, low-amplitude noise superimposed on the sine wave (as contrasted with impulses, which are one-shot,high-amplitude events superimposed on the sine wave). HFN graphs are printed whenever the averaged HFN on a channel exceeds the HFN surge threshold that you chose. If the surge continues for longer than 16 seconds, an "HFN swell ended" graph is printed when the average HFN falls back below the threshold that you chose.

HFN disturbance graphs are 20 seconds long. You can also print HFN stripcharts for each channel that are 1, 3, 6, 12, or 24 hours long.

Parts of the HFN Surge Graph

1 Site name. Defaults to "BMI 8800 Site" or can be changed by the user in the Setup Menu.

2 Channel name. The PowerScope will automatically select a channel name if you choose one of the standard power types (single-phase, three-phase delta, etc.), or the user can enter one of their own choice in the Setup Menu.

3 Date and time. This is the date and time the disturbance was recorded. Time in the upper right is shown to a resolution of .01 seconds. You should generally treat HFN surge events that occur within 0.2 seconds of another event as simultaneous with the other event due to the time constant of the HFN averaging circuit.

4 Trigger. This will read either HFN Swell or HFN Swell Ended. If a noise swell ends within 16 seconds, the entire disturbance is shown on a single HFN Swell graph and a Swell Ended graph will not be printed.

5 Maximum HFN. The maximum HFN peak-to-peak voltage.

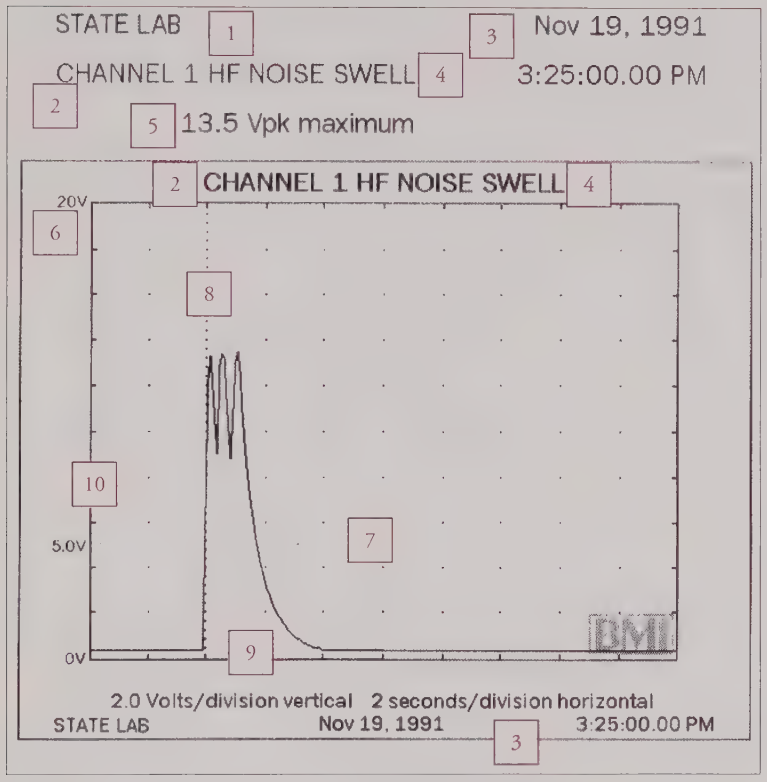
6 Vertical full scale. This value is fixed at 20.0 volts.

7 HFN swell threshold line. A dashed line indicating the HFN swell thresholds that you chose.

8 Trigger line. The point in time when the PowerScope determined that an HFN swell occurred. Points to the left of this line are 4 seconds of pre-trigger data, and points to the right are 16 seconds of post-trigger data.

9 Horizontal scale. Fixed at 2 seconds per division. Each horizontal division is shown by tick marks along the top and bottom borders, and by dots in the graph area.

10 Vertical scale. Each vertical division is shown by tick marks along the left and right borders of the upper graph, and by dots in the graph area.


STATE LAB
1
3
Nov 19, 1991
CHANNEL 1 HF NOISE SWELL
4
3:25:00.00 PM
2
5
13.5 Vpk maximum
2
CHANNEL 1 HF NOISE SWELL
4
20V
6
8
10
5.0V
7
0V
9
BMI
2.0 Volts/division vertical 2 seconds/division horizontal
STATE LAB
Nov 19, 1991
3:25:00.00 PM
3

Reports and Graphs

How to Read Strip Charts

You can set your PowerScope to print stripcharts of any signal recorded: RMS voltage, current, frequency, noise, impulses, temperature, humidity, etc. You can select from report lengths of 1, 3, 6, 9, 12, or 24 hours. Strip charts are printed on the hour; in other words, if you select 12 hour strip charts, they will be printed at noon and midnight, regardless of when you start monitoring.

Gaps on a Strip Chart

If there are gaps in your strip chart data, it is because no data was available during that interval. You may have taken the PowerScope out of monitor mode (to get a status reading, for example), or you may not have started monitoring yet (for example, if you start monitoring at noon, and you have asked for 24 hour strip charts, the strip charts are printed at the first midnight will not have any data on the left half).

Dual Strip Charts

Where necessary, your PowerScope will print dual strip charts. These are commonly required for temperature and temperature rate-of-change, humidity and humidity rate-of-change, and 50-volt proportional supply average voltage and voltage spread. You don't have to do anything extra to get these graphs, the PowerScope prints them automatically.

Printing Strip Charts

Your PowerScope will print all of the strip charts you want automatically at the interval you have selected. If it detects that you are about to take an action, such as changing a threshold, that might disrupt the data that it has gathered, it will ask you if you want to print the strip charts first. You can either print them, clear them, or go back to monitoring by pressing **Monitor**.

Parts of a Typical Strip Chart

1. Site name. Defaults to "BMI 8800 Site" or can be changed by the user in the Setup Menu.

2. Channel name. The PowerScope will automatically select a channel name if you choose one of the standard power types (single-phase, three-phase delta, etc.), or the user can enter one of their own choice in the Setup Menu.

3. Date and time. This is the date and time the strip chart printed. The data on the strip chart always covers the interval shown at the bottom of the graph. The strip chart can sometimes be printed several minutes after the time at the right edge of the graph, particularly if you have requested a large number of strip charts.

4. Minimum and maximum values. The minimum and maximum values observed during the strip chart interval.

5. Vertical full scale. Typically is set by the surge threshold for the signal.

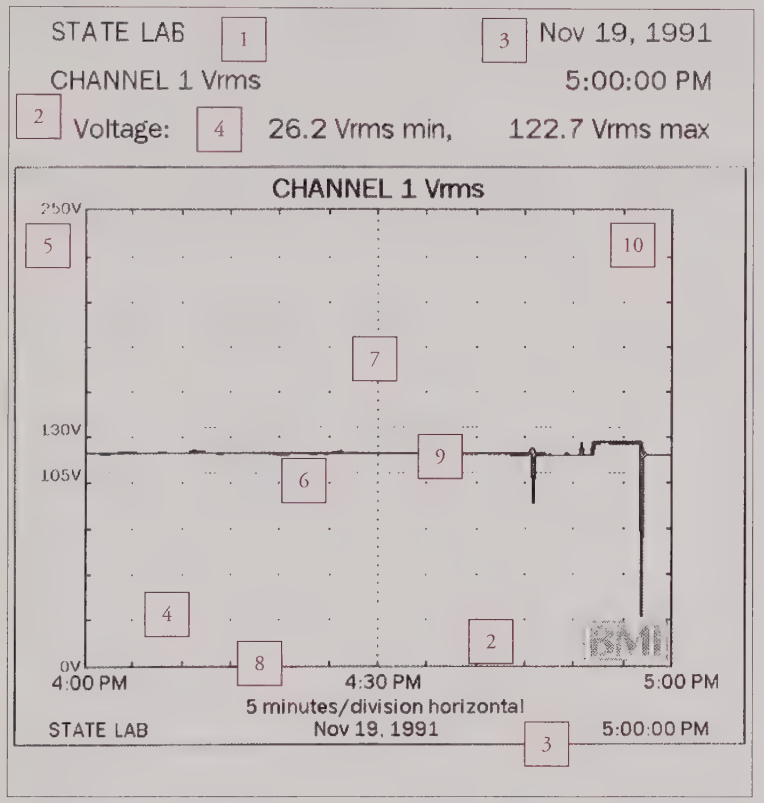
6. Threshold line(s). A dashed line of lines indicating the thresholds that you selected for this signal.

7. Mid-point line. The middle of the graph; associated with the time printed at the bottom center of the graph.

8. Horizontal scale. Set by the strip chart interval you chose; may be 5 minutes, 15 minutes, 30 minutes, 1 hour, or 2 hours per division. Each horizontal division is shown by tick marks along the top and bottom borders, and by dots in the graph area.

9. Signal spread. A single line cannot accurately represent signals on a strip chart because each pixel represents up to 6 minutes of data, so the PowerScope generally prints two black lines, corresponding to the maximum and minimum values of the signal during each pixel, with gray in between the lines. If the signal is stable enough to be correctly shown as a single line, a single line is printed.

10. Amps indicator. On current strip charts, the word "amps" appears in the upper right corner as a reminder.


STATE LAB
1
3
Nov 19, 1991
CHANNEL 1 Vrms
5:00:00 PM
2
Voltage:
4
26.2 Vrms min,
122.7 Vrms max
CHANNEL 1 Vrms
250V
5
10
7
130V
105V
9
6
4
2
8
0V
4:00 PM
4:30 PM
5:00 PM
5 minutes/division horizontal
STATE LAB
Nov 19, 1991
3
5:00:00 PM

Reports and Graphs

How to Read Harmonics/Spectrum Analysis Graphs
You trigger harmonic analysis and spectrum analysis of all main PowerScope channels by pressing **Snapshot** followed by the **Scroll Up** arrow.

What is Harmonic and Spectrum Analysis?
Any repetitive waveform can be broken down into a sum of pure sine waves at different frequencies and amplitudes using a technique called Fourier analysis. This process has practical implications; for example, when you take a distorted waveform and pass it through a transformer, the transformers efficiency is lower than it would be with a pure sine wave, and its exact efficiency can most easily be calculated from its efficiency at each of the component frequencies of the distorted waveform.

The 8800 has two standard ways of looking at the component frequencies: a list of harmonics (integer multiples of the fundamental frequency), and a spectral graph. The list of harmonics shows the fundamental as having 100% amplitude; all of the other frequencies are expressed as a percentage of the fundamental amplitude. The spectrum analysis graphs amplitude against frequency, so it shows non-harmonic content as well.

Parts of a Harmonics Report

1. List of the harmonics. The odd multiples of the fundamental frequency are listed in the left column, and the even multiples are listed in the right column. For power monitoring purposes, the fundamental is almost always 50 Hz, 60 Hz, 400 Hz, or 415 Hz.

2. Harmonic content. The amplitude of this harmonic expressed as a percentage of the fundamental. If this line is blank, the amplitude of this harmonic is less than 0.2%.

3. Indicated phase position. The phase of the harmonic with respect to the fundamental. If this line is blank, the amplitude of this harmonic is less than 0.2%.

4. Sums of odd and even harmonics. The geometric sums of the odd and even harmonics, respectively.

5. Total harmonic distortion. The geometric sum of all the harmonics.

Parts of a Spectrum Analysis

6. Site name. Defaults to "BMI 8800 Site" or can be changed by the user in the Setup Menu.

7. Channel name. The PowerScope will automatically select a channel name if you choose one of the standard power types (single-phase, three-phase delta, etc.), or the user can enter one of their own choice in the Setup Menu.

8. Date and time. This is the time the spectrum was recorded and will immediately follow the time on the associated waveshape graph.

9. Vertical full scale. Automatically scales to as high as 500% based on the largest amplitude signal other than the fundamental.. The fundamental is always 100%; on graphs with 50%, 25%, or 10% full scale, the fundamental is the line that goes to the top of the graph (and continues on up to 100%). There are 10 divisions vertically, so each division is either 50%, 25%, 10%, 5%, 2.5%, or 1% depending on the full scale value.

10. Horizontal full scale. Automatically set to either 1 kHz or 2 kHz. All of the analysis is carried out to 2 kHz; if there is no signal greater than 0.2% beyond 1 kHz, the horizontal scale is set to 1 kHz. There are 10 divisions horizontally, so each division is either 100 Hz or 200 Hz, depending on the full scale value.

11. Voltage or current spectrum. Indicates whether it is a voltage or current harmonic spectrum.

LAB [6] [8] Feb 7, 1992

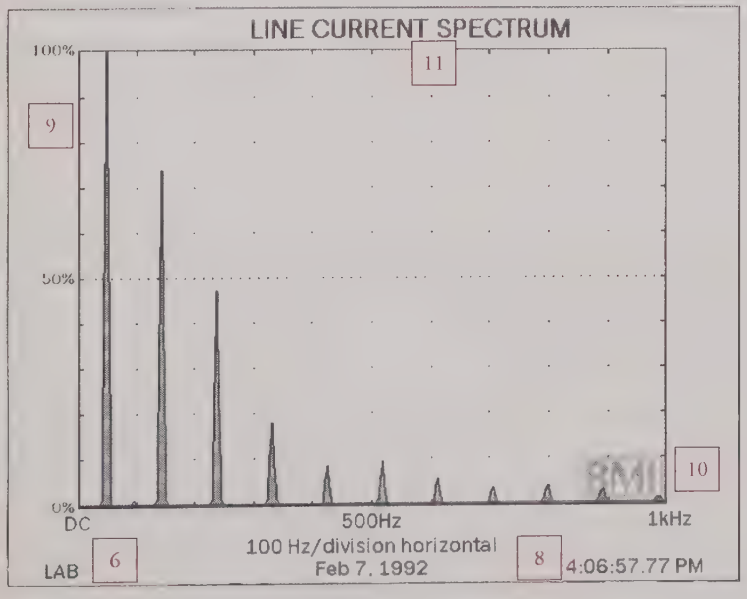
LINE CURRENT SPECTRUM [7] 4:06:57.77 PM

Fundamental frequency: 60.0 Hz

[1] Harmonic	[2] Percent	Sine [3] Phase	[1] Harmonic	[2] Percent	Sine [3] Phase
Fund	100.0%	0°	2nd	0.3%	271°
3rd	73.6%	183°	4th		
5th	47.0%	353°	6th		
7th	17.8%	155°	8th		
9th	8.0%	260°	10th		
11th	8.9%	28°	12th		
13th	5.3%	179°	14th		
15th	2.9%	283°	16th		
17th	3.4%	50°	18th		
19th	2.4%	199°	20th		
21st	1.2%	317°	22nd		
23rd	1.4%	64°	24th		
25th	0.9%	205°	26th		
27th	0.4%	315°	28th		
29th	0.4%	323°	30th		
31st			32nd		
33rd	0.3%	204°			

[4] Odd: 90.2% [4] Even: 0.3%

[5] Thd: 90.2%



[11] [9] [10] [6] [8]

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When should your PowerScope be calibrated?
It is recommended that your PowerScope be calibrated once per year. Each RMS voltage channel has eight ranges; and each RMS current channel has five ranges. The calibration report shows the performance of every range on each voltage and current channel. Each range is marked either with a calibration due date, which means it is still within calibration, or "Uncalibrated". If the range is marked "Uncalibrated" it may be functional but is either outside the calibration limits or has passed the calibration due date.

BMI's Calibration Service
BMI offers full calibration services for any BMI instrument. Calibration is guaranteed and traceable to NIST. Call BMI Technical Support at (415) 570-5355 for details or to schedule a calibration.

Calibrating the PowerScope at your site
BMI recommends that you establish a calibration calendar so that your PowerScope is calibrated by a designated person at specified times. Performing a calibration will clear all previous calibration data.

Equipment you will need
- AC voltage source (0 - 700 Vrms)
- True RMS voltmeter/ammeter with 4.5 digit accuracy (such as HP 3458A Multimeter)
- BMI current calibration adapter (BMI order number CB-880, call BMI Sales Administration to order 415/570-5355)

Printing a Calibration Report
The Calibration Report will show the most recent calibration information. To print a Calibration Report press [CALIBRATE].

The Calibration Menu
To access the Calibration Menu press [CALIBRATE] followed by [^]. (The complete Calibration Menu is included at the end of this section). The Calibration Menu allows you to perform several tasks:

1) **Setup** - Lets you enter the calibration information including the next calibration due date, the name of the person performing the calibration, and the NIST trace number. The PowerScope then automatically proceeds to the voltage and current calibration.

2) **Voltage** - Lets you initiate the voltage calibration procedure. Be sure to have your voltage calibration equipment set up. For each of the eight voltage ranges, the PowerScope will prompt you to set a voltage within a specified range. You enter the source voltage shown on the voltmeter. Press [Scroll Down] to enter the calibration value for each voltage range.

3) **Current** - Lets you initiate the current calibration procedure. Be sure to have your equipment for current calibration set up properly. For each of the five current ranges, the PowerScope will prompt you to set a current within a specified range. You enter the current source value shown on the ammeter. Press [Scroll Down] to enter the calibration value for each current range.

4) **Print** - Lets you print the calibration report.

This calibration procedure should only be performed by qualified personnel. If you would like your PowerScope calibrated by BMI, contact BMI Technical Support.

Calibrating your 8800 PowerScope

1) Press [CALIBRATE] followed by SCROLL UP arrow.
2) Use the Value Up and Value Down buttons to position "Calibrate: Setup" in the display.
3) Press Scroll Down arrow.
4) Due Date. Use the keypad and Scroll Left and Scroll Right arrows to enter the due date of the next calibration. (Use the number keys to enter both letters and numbers. For example, to enter the letter 'B', press [2ABC] three times). We recommend a one year calibration cycle.
5) Calibrated by. You may enter up to five characters from the keypad to identify the person performing the calibration. Press Scroll Down to enter.
6) NIST trace number. You may enter up to eight characters from the keypad to identify the NIST trace number. Press Scroll Down to enter.

8 Calibration

You may discontinue the calibration procedure at any time by resetting the PowerScope – press the Cancel Printer button followed by Scroll Up arrow. If you discontinue the calibration procedure in this way, no new calibration data will be stored in memory.

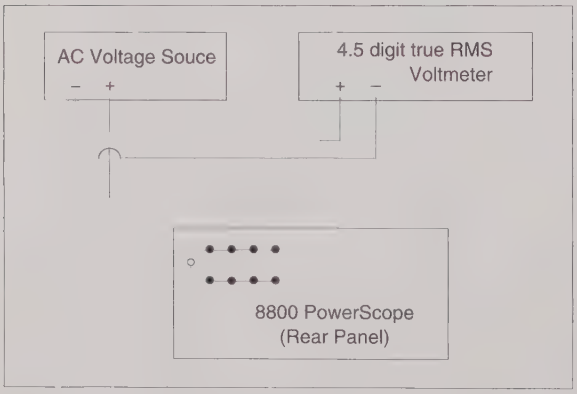
New calibration data will not be saved until you exit the calibration menu, either by completing the calibration procedure or by selecting another function key such as Meters, Snapshot, Status, etc. Once the new data is stored, the old calibration data is lost. The 8800 will display the message "Saving cal data..."

7) Set up RMS Voltage Channels Calibration. If necessary, use the Value Up, Value Down buttons to display "Calibrate: Voltage". Press Scroll Down arrow to select.

Note: You must calibrate *all* voltage channels at the same time.

Connect the voltage source in parallel with the voltage meter and to voltage channel one on the PowerScope (see Figure 1). (Be sure to let the equipment warm-up for one hour before performing the calibration). Use blue jumpers to connect the voltage (in parallel) to the rest of the PowerScope voltage channels.

8) Adjust the voltage source so the meter reads zero.



■ Figure 8.1: 8800 Voltage Calibration Equipment Setup

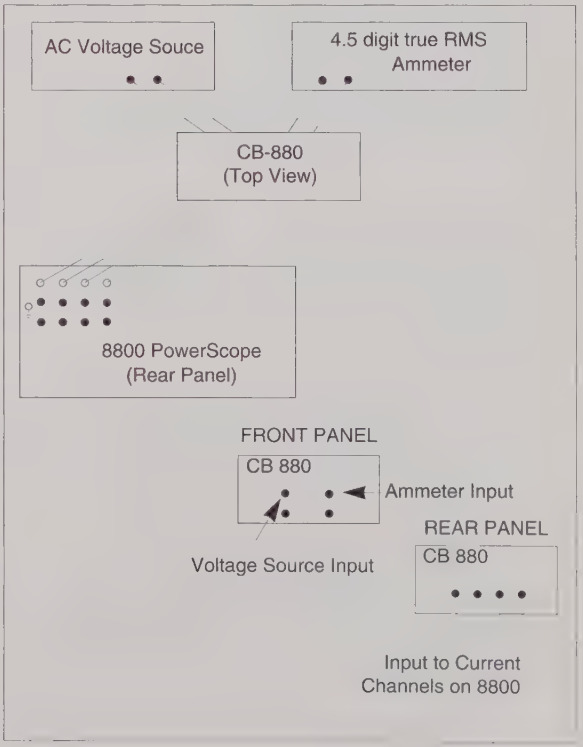
Enter the value zero by using the PowerScope keypad. Press [Scroll Down] to enter the calibration value.

9) For each of the eight ranges, the PowerScope will prompt you to enter a value within a given range. Adjust the voltage source so that the voltmeter reading is within the specified range. You enter the source voltage shown on the voltmeter and press Scroll Down to enter the calibration value for each voltage range.

10) Set up RMS Current Channel Calibration. If necessary, use the Value Up, Value Down buttons to display "Calibrate: Current". Press Scroll Down arrow to select.

Note: You must calibrate *all* current channels at the same time.

To calibrate the current channels, connect the voltage source and the ammeter to the front panel of the BMI current calibration box as shown in Figure 2. Connect one cable from the current calibration box to each of the current channels.



■ Figure 8.2: 8800 Current Calibration Equipment Setup

11) Adjust the voltage source so the ammeter reads zero. Enter the value zero by using the PowerScope keypad. Press [Scroll Down] to enter the calibration value.

12) For each of the five current ranges, the PowerScope will prompt you to enter a current value within a specified range. You adjust the voltage source so that the meter displays a current value within the specified range. Use the PowerScope keypad to enter this number. Press [Scroll Down] to enter the calibration value for each current range.

13) When the calibration procedure is completed the 8800 will print the new calibration report. The new calibration data will not be saved until you exit the calibration menu. Once the new data is stored, the old calibration data is lost. The 8800 will display the message "Saving cal data...". To prevent the 8800 from saving the new calibration data you must reset the unit by pressing Cancel Printer button followed by the Scroll Up arrow.

14) Calibration verification. Print a calibration report to verify the 8800 PowerScope has calibrated correctly. To do this, press [CALIBRATE]. All calibrated ranges will show a date in the Status column (see Figure 3).

==========

8800 Aug 20, 1992

CALIBRATION REPORT 7:12 PM

Instrument Serial number:

Channel 1

Last calibration date:	8/20/92
Last calibrated by:	RAG
Last NIST trace #:	HP3458A
Next calibration due:	8/93

Voltage Ranges:

Range Fullscale (Vrms)	Calibration Voltage (Vrms)	Status (Date due)
0.0	0.00	8/93
12.5	7.94	8/93
25.0	16.37	8/93
50.0	32.71	8/93
125.0	82.8	8/93
250.0	161.7	8/93
333.0	222.8	8/93
500.0	332.8	8/93
1000.0	606.5	8/93

Current Ranges:

Range Fullscale (uArms)	Calibration Current (uArms)	Status (Date due)
0	0.0	8/93
300	194.5	8/93
600	388.7	8/93
1500	970.0	8/93
3000	1917.0	8/93
5000	2801.0	8/93

■ **Figure 8.3: 8800 Calibration Report**

The Calibration Menu

Press Calibrate followed by Scroll Up arrow to access the Calibration Menu.

You may discontinue the calibration procedure at any time by resetting the PowerScope – press the Cancel Printer button followed by Scroll Up arrow. If you discontinue the calibration procedure in this way, no new calibration data will be stored in memory.

New calibration data will not be saved until you exit the calibration menu, either by completing the calibration procedure or by selecting another function key such as Meters, Snapshot, Status, etc. Once the new data is stored, the old calibration data is lost. The 8800 will display the message "Saving cal data..."

Calibrate: Setup

Use the Scroll Down arrow to move through menu selections.

Date due:

Calibrated by:

NIST trace:

End of menu

^ v

Calibrate: Setup
Calibrate: Voltage
Calibrate: Current
Calibrate: Print

Calibrate: Voltage

Use the Scroll Down arrow to move through menu selections.

O Vrms:

7.6-8.4 Vrms:

15.1-16.7 Vrms:

30.2-33.4 Vrms:

75.5-83.5 Vrms:

150-170 Vrms:

Menu continued

^ v

Calibrate: Setup
Calibrate: Voltage
Calibrate: Current
Calibrate: Print

Use Key Pad and Scroll Left and Right arrows to display the current. Press the Scroll Down arrow to enter the calibration value.

Calibration

200-225 Vrms:

300-335 Vrms:

604-670 Vrms:

End of menu

Calibrate: Current

Use the Scroll Down arrow to move through menu selections.

Calibrate: Setup

Calibrate: Voltage

Calibrate: Current

Calibrate: Print

0 µArms:

Use Key Pad and Scroll Left and Right arrows to display the current. Press the Scroll Down arrow to enter the calibration value.

180-200 µArms:

360-400 µArms:

900-1000 µArms:

1.8-2.0 mArms:

1.8-2.0 mArms:

End of menu

Calibrate: Print

Prints Calibration Report

Calibrate: Setup

Calibrate: Voltage

Calibrate: Current

Calibrate: Print

Using the Troubleshooting Chart

Use the Troubleshooting Chart to narrow down the possible causes of any problem with your PowerScope. When there are multiple possible causes, they'll all be listed with a probability.

WARNING! The servicing instructions in this manual are for use by qualified personnel only. To reduce the risk of electrical shock, do not perform any servicing unless you are qualified to do so.

Incoming ground: The power plug is grounded. For continued protection against risk of electrical shock and fire, do not defeat the grounded plug.

Ventilation: This unit is fan cooled. For continued protection against risk of electrical shock and possible fire hazard, do not allow the fan opening to become blocked.

Boards and Modules

Attenuator Module	On rear of PowerScope; includes 4 black sockets, 4 red sockets, and 1 green socket
Mother Board	Large rectangular board standing vertically near the center of the chassis
Key Board and Display Board	Small "L" shaped board; has front panel key switches
Power Supply board with Printer Interface	Small board standing vertically in the center of the chassis
Math Processor	PC board with green handle
Acquisition Processor	PC board with blue handle (one per voltage/current channel, 4 max.)
I/O Processor	PC board with red handle
Storage Processor	PC board with yellow handle

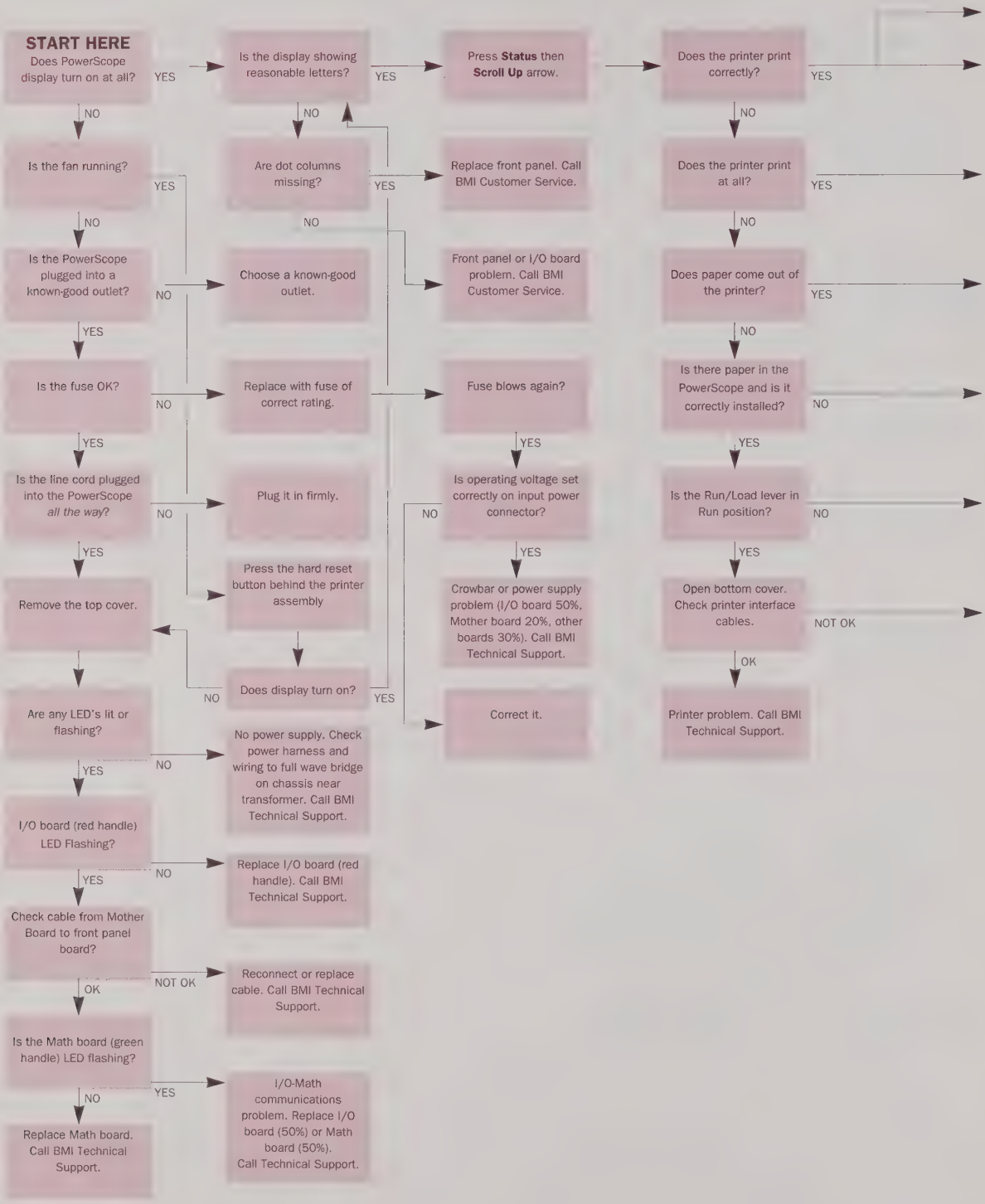
Opening Your PowerScope

1. Disconnect all measurement connections from your PowerScope. Unplug the AC or DC power cord.

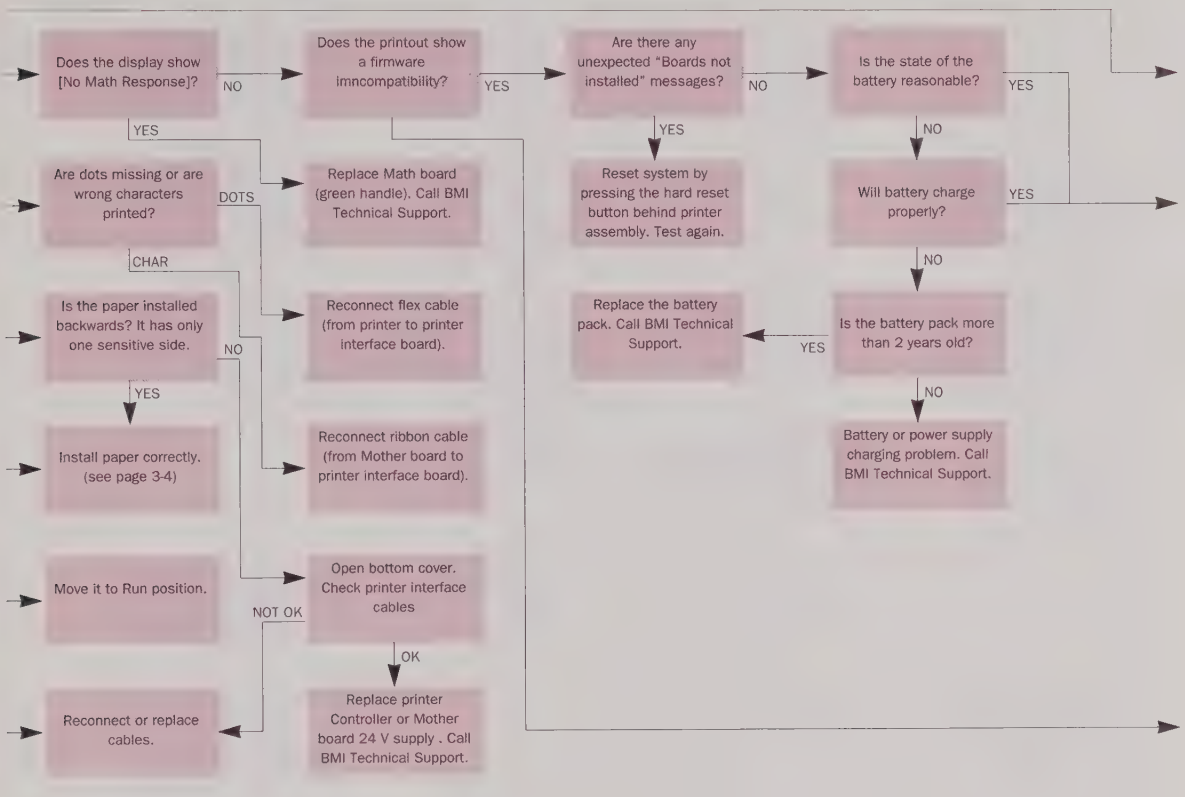
2. Remove the top and bottom covers by removing twelve screws (including two under the handle). The covers may catch slightly under the chrome handle trim; free it gently.

3. If necessary, remove the board retainer assembly (placed across the handles of the boards to prevent board movement).

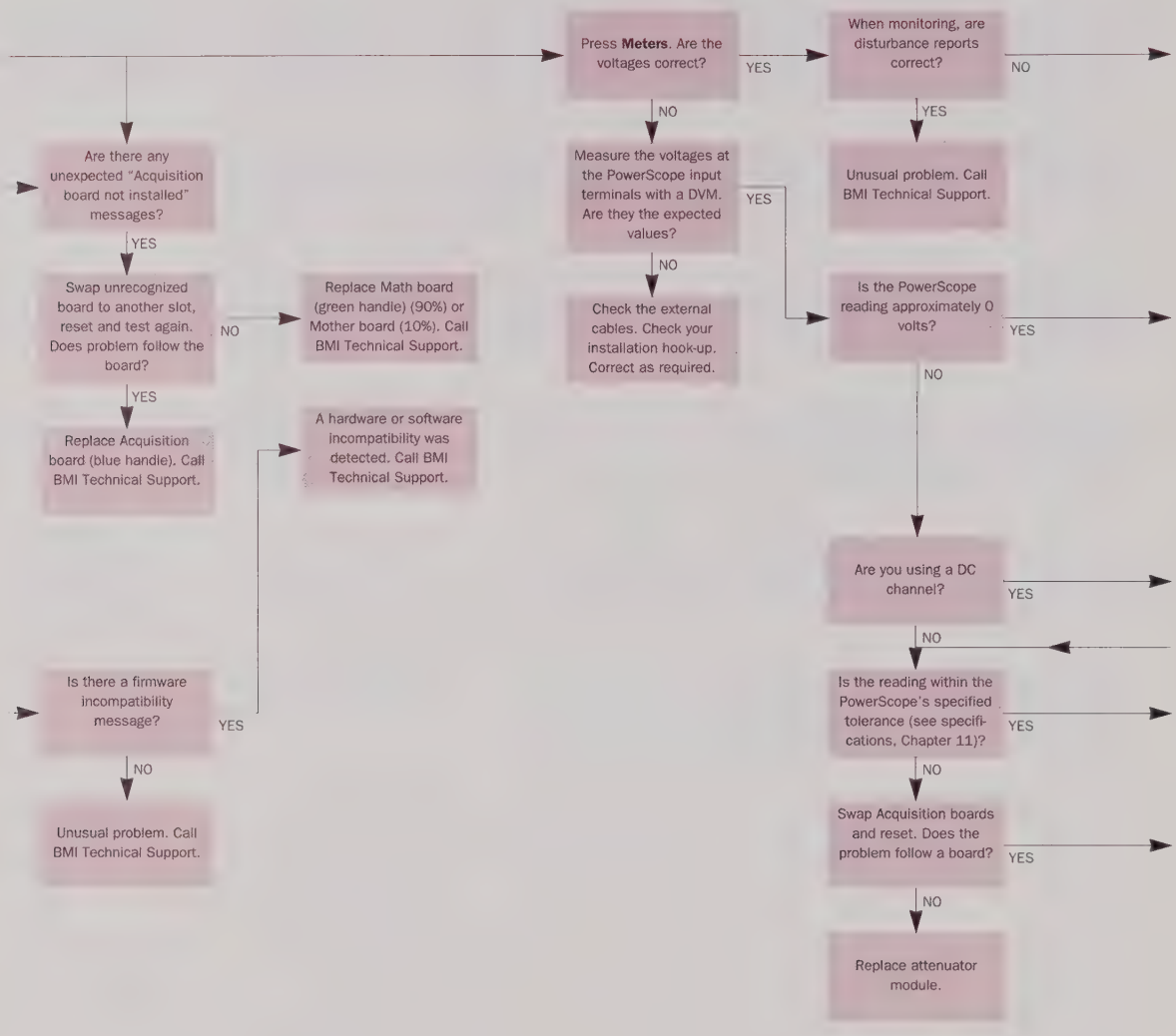
9 Troubleshooting

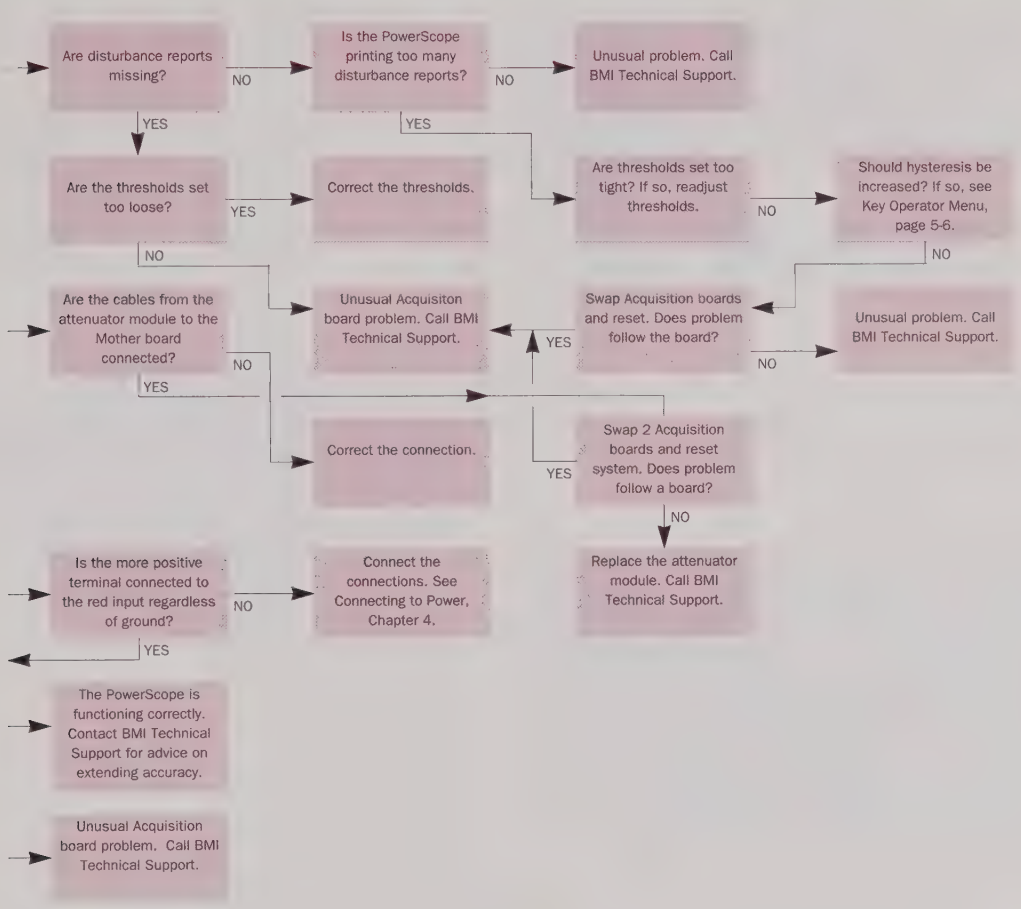

START HERE
Does PowerScope display turn on at all?
YES
NO
Is the fan running?
YES
NO
Is the PowerScope plugged into a known-good outlet?
NO
YES
Choose a known-good outlet.
Is the fuse OK?
NO
YES
Replace with fuse of correct rating.
Is the line cord plugged into the PowerScope all the way?
NO
YES
Plug it in firmly.
Remove the top cover.
Press the hard reset button behind the printer assembly
Are any LED's lit or flashing?
NO
YES
Does display turn on?
NO
YES
No power supply. Check power harness and wiring to full wave bridge on chassis near transformer. Call BMI Technical Support.
I/O board (red handle) LED Flashing?
NO
YES
Replace I/O board (red handle). Call BMI Technical Support.
Check cable from Mother Board to front panel board?
NOT OK
OK
Reconnect or replace cable. Call BMI Technical Support.
Is the Math board (green handle) LED flashing?
YES
NO
I/O-Math communications problem. Replace I/O board (50%) or Math board (50%). Call Technical Support.
Replace Math board. Call BMI Technical Support.
Is the display showing reasonable letters?
YES
NO
Are dot columns missing?
YES
NO
Replace front panel. Call BMI Customer Service.
Front panel or I/O board problem. Call BMI Customer Service.
Fuse blows again?
YES
NO
Is operating voltage set correctly on input power connector?
YES
NO
Crowbar or power supply problem (I/O board 50%, Mother board 20%, other boards 30%). Call BMI Technical Support.
Correct it.
Press Status then Scroll Up arrow.
Does the printer print correctly?
YES
NO
Does the printer print at all?
YES
NO
Does paper come out of the printer?
YES
NO
Is there paper in the PowerScope and is it correctly installed?
NO
YES
Is the Run/Load lever in Run position?
NO
YES
Open bottom cover. Check printer interface cables.
NOT OK
OK
Printer problem. Call BMI Technical Support.

◆ *Press the HELP! button at any time for more information*


Does the display show [No Math Response]?
NO
Does the printout show a firmware imncompatibility?
YES
Are there any unexpected "Boards not installed" messages?
NO
Is the state of the battery reasonable?
YES
YES
Are dots missing or are wrong characters printed?
DOTS
Replace Math board (green handle). Call BMI Technical Support.
YES
Reset system by pressing the hard reset button behind printer assembly. Test again.
NO
Will battery charge properly?
YES
CHAR
NO
Is the paper installed backwards? It has only one sensitive side.
Reconnect flex cable (from printer to printer interface board).
Replace the battery pack. Call BMI Technical Support.
YES
Is the battery pack more than 2 years old?
NO
YES
Install paper correctly. (see page 3-4)
Reconnect ribbon cable (from Mother board to printer interface board).
Battery or power supply charging problem. Call BMI Technical Support.
Move it to Run position.
Open bottom cover. Check printer interface cables
NOT OK
OK
Reconnect or replace cables.
Replace printer Controller or Mother board 24 V supply . Call BMI Technical Support.

Troubleshooting


Press **Meters**. Are the voltages correct?
YES
When monitoring, are disturbance reports correct?
NO
YES
Unusual problem. Call BMI Technical Support.
NO
Measure the voltages at the PowerScope input terminals with a DVM. Are they the expected values?
YES
NO
Check the external cables. Check your installation hook-up. Correct as required.
Is the PowerScope reading approximately 0 volts?
YES
NO
Are there any unexpected "Acquisition board not installed" messages?
YES
Swap unrecognized board to another slot, reset and test again. Does problem follow the board?
NO
Replace Math board (green handle) (90%) or Mother board (10%). Call BMI Technical Support.
YES
Replace Acquisition board (blue handle). Call BMI Technical Support.
A hardware or software incompatibility was detected. Call BMI Technical Support.
Are you using a DC channel?
YES
NO
Is there a firmware incompatibility message?
YES
NO
Unusual problem. Call BMI Technical Support.
Is the reading within the PowerScope's specified tolerance (see specifications, Chapter 11)?
YES
NO
Swap Acquisition boards and reset. Does the problem follow a board?
YES
NO
Replace attenuator module.


Are disturbance reports missing?
NO
Is the PowerScope printing too many disturbance reports?
NO
Unusual problem. Call BMI Technical Support.
YES
YES
Are the thresholds set too loose?
YES
Correct the thresholds.
Are thresholds set too tight? If so, readjust thresholds.
NO
Should hysteresis be increased? If so, see Key Operator Menu, page 5-6.
NO
NO
Are the cables from the attenuator module to the Mother board connected?
NO
Unusual Acquisiton board problem. Call BMI Technical Support.
YES
Swap Acquisition boards and reset. Does problem follow the board?
NO
Unusual problem. Call BMI Technical Support.
YES
YES
Correct the connection.
Swap 2 Acquisition boards and reset system. Does problem follow a board?
YES
NO
Is the more positive terminal connected to the red input regardless of ground?
NO
Connect the connections. See Connecting to Power, Chapter 4.
Replace the attenuator module. Call BMI Technical Support.
YES
The PowerScope is functioning correctly. Contact BMI Technical Support for advice on extending accuracy.
Unusual Acquisition board problem. Call BMI Technical Support.

Waveshape Fault Detection

The 8800 PowerScope uses a patented digital technique to detect changes in the shape of the voltage waves that it monitors. The technique is described more fully in a technical paper, available from BMI, titled *A Floating-Window Algorithm for Detecting Certain Power Faults That Disrupt Sensitive Electronic Loads.* The technique is to digitally sample the waveform, and compare the samples for each cycle to the corresponding samples in the previous cycle. If the samples differ by more than a user-defined threshold value (the tolerance) for a threshold length of time (the duration), a waveshape fault graph will be printed. Both the tolerance and the duration are defined by the user. This technique readily identifies sub-cycle drop-outs, substantial change in harmonic distortion, switching to or from a non-sinusoidal power source, and so on.

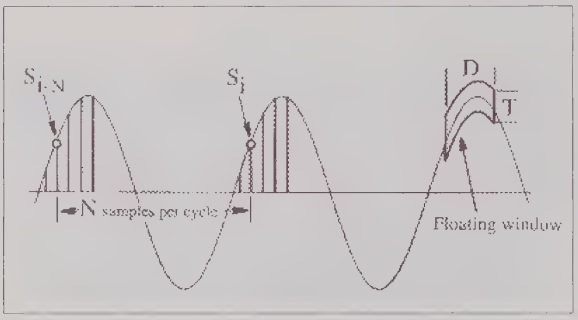
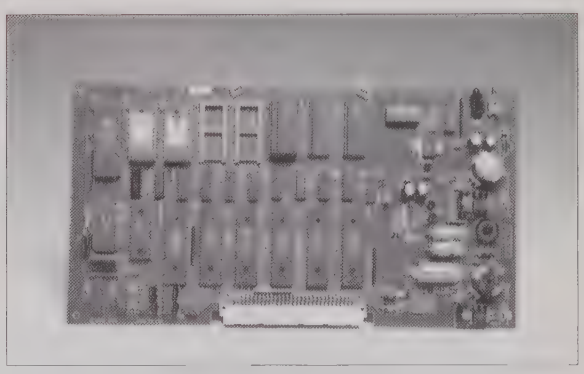


Figure 10.1: Waveshape Fault Detection Technique

Impulse Capture

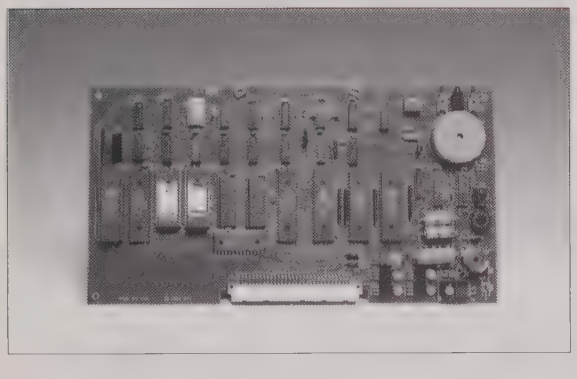
The 8800 PowerScope uses a patented digital system for detecting, capturing, and analyzing impulses. This system is described more fully in a technical paper, available from BMI, titled *A System for Capturing and Presenting Short-Duration Voltage Impulses on AC Power Lines.*

The incoming signal is split into high-frequency and low-frequency components. The low-frequency component is digitally sampled at 5.12 KHz, and the high-frequency component is digitally sampled at 4.0 MHz (250 nano-seconds). If an impulse appears in the high–frequency section in excess of the user's threshold, pre-trigger and post-trigger samples are captured in both sections for analysis. The circuitry can capture data for as many as seven impulses. The captured samples in the high-speed section are examined, and the horizontal display window is adjusted for the best resolution for each impulse. The full-scale vertical values for both sections are controlled by software.

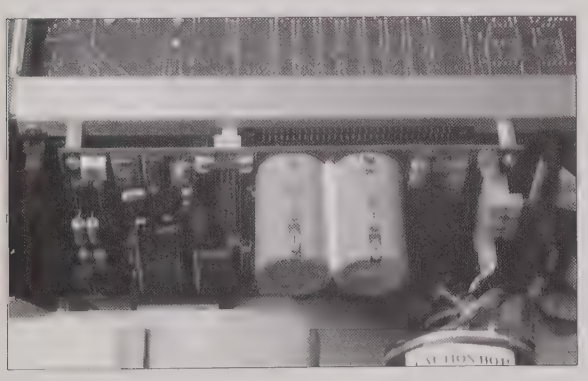


Math Processor

The Mathematics Processor has a green handle and green labels on its EPROMs. It is at the center of all the processing in the PowerScope and is responsible for all of the non-volatile memory, the Setup and Report Menus and the clock and calendar. While the instrument is monitoring, the Mathematics Processor periodically requests data from the Acquisition Processors for the stripchart reports. It also accepts asynchronous array disturbance reports from the Acquisition Processors. When these reports arrive, the Mathematics Processor performs any necessary math operations, does scaling and formatting, and passes the reports on to the I/O Processor. The Mathematics Processor also compiles the Configuration Report.

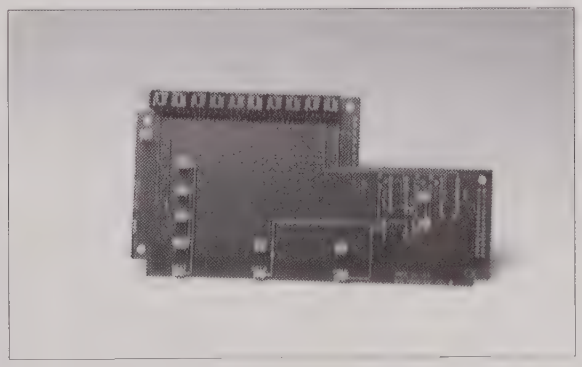


I/O Processor
The I/O Processor has a red handle and red labels on its EPROMs. It is responsible for communicating with the printer interface, the front panel, and the Mathematics Processor (note that the RS-232 port and the modem both talk directly to the Mathematics Processor, not the I/O Processor). It also performs a basic test of the Mathematics Processor when the **Status** and **Scroll Up arrow** buttons are pressed (the Mathematics Processor tests the rest of the instrument). It also holds all of the Help! messages.



Printer Controller and Power Supply Board
The printer controller accepts 8-bit parallel characters from the I/O Processor. It controls the printer-advance motor and turns the thermal print elements on and off. It also supplies raw power for the Math, I/O, Acquisition and Storage processors. It provides switching for UPS battery (internal).

Printer
The printer connects directly to the printer interconnect board through a flat cable (for the print-head thermal elements and sensors) and twisted wires (for status sensors and the paper advance motor). Since the printer has a minimum number of moving parts – the printer head doesn't move – it is remarkably reliable. To maintain print quality you must use the recommended thermal paper.



Display Board
The display board connects through a 26-wire cable to the Mother Board, where all of the connections are routed directly to the I/O Processor. Data for the 20-character display is fed serially for the first 7-dot-column for each of the 20 characters, then displayed, then data for the second dot-column for each of the 20 characters is fed serially and displayed, etc.

Keyboard
The keyboard uses a matrix strategy, with the first key depression causing an interrupt. A keyboard key sequence can be used to lock the keyboard to prevent accidental activation or 8800 PowerScope reactions.

10 Theory of Operation

Mother Board
The Mother Board is the central connection point for all signals in the 8800 PowerScope.

Power Supply
The PowerScope can use three sources of power: external AC power, internal NiCad batteries, or an external 12 Vdc supply, such as an automobile battery. Unlike some other power monitors, the AC input power is not connected to any impulse suppression devices, so the instrument can be powered from the same line it is monitoring without affecting the validity of the information. The input AC power feeds a specially constructed power transformer with 6 KV of isolation between any input terminal and ground. Additional shielding is provided to isolate the input of the transformer and the output. The AC supply and external PC are diode OR'd so that either can supply power to the instrument. An electronic switch controls the operation of the internal NiCad batteries (UPS).

Mechanical
The 8800 PowerScope was designed as a field service instrument. Rugged cast-aluminum front and rear bezels are coupled with extensive internal bracing and clamping. External parts are finished with two-part polyurethane, internal parts are alodined, and all fasteners are chemically locked in place.

RMS Voltage Accuracy[1]

±0.2% of range ±1% of reading or 0.5 V whichever is greater, DC or 45-450 Hz
Full scale ranges: 12.5 V, 25 V, 50 V, 125 V, 250 V, 333 V, 500 V, 1000 V

RMS Current Accuracy[1]

Refer to the 8800 PowerScope data sheet for specifications.

Impulse

Impulse capture: 8 bit data at 4 mega-samples per second
Full scale ranges: 100 V, 200 V, 400 V, 800 V, 1600 V, 3200 V, 6400 V
Minimum impulse trigger amplitude: 20 V

Harmonic Analysis

Fundamental frequency: 45-415 Hz
Maximum harmonic frequency: 2 kHz

General

Physical = 15 in x 15.3 in x 6 in (38 cm x 39 cm x 15 cm), 28 pounds (13 kg)
Power = 100-145 Vac/200-277 Vac/230-277 Vac, 60 Hz, 150 VA max.
100-125 Vac/200-255 Vac/230-277 Vac, 50 Hz, 150 VA max.
110-155 Vac/210-277 Vac/245-277 Vac, 400 Hz, 150 VA max.
11-16 Vdc (for external 12 V battery)
UPS: internal NiCad batteries, 15 minutes at maximum setting
Environment[2]
Operating Temperature: 5°C to 40°C Storage: -20°C to 60°C
Operating Humidity: 35% to 85% RH, noncondensing Storage: 5% to 90% RH, noncondensing

Input Characteristics

	Voltage	Current
Type	solid state differential DC coupled	BMI SmartProbe
Impedance	2 MΩ to ground <50 pF to ground	
Connectors	high-voltage safety	BMI SmartProbe

Notes:

1. Requires 8800 PowerScope firmware revision 2.0. Contact BMI Technical Support for availability.

2. Limited by printer operating range.

Specifications subject to change without notice.

11 Specifications

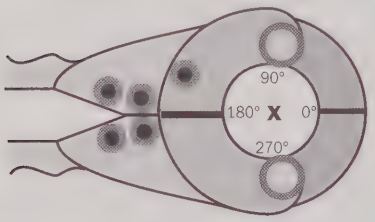
SmartProbe Accuracy

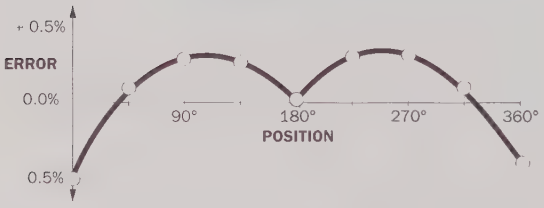
Sources of SmartProbe Current Errors

The principle sources of current measurement errors with A-116 and A-120 SmartProbes are conductor position, conductor angle, and mating of clamp-on jaw. The descriptions and figures contained here apply to the A-116, but the principles apply to all clamp-on current probes.

Conductor Position

The A-116 SmartProbe has its accuracy specified with the conductor positioned in the center of the jaws (position X in Figure 11-1). Figure 11-1 shows how the accuracy varies with conductor position for the A-116 600 amp SmartProbe.



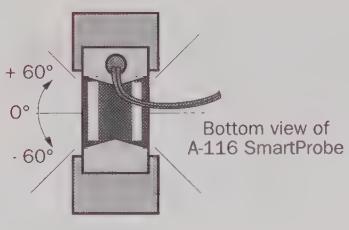


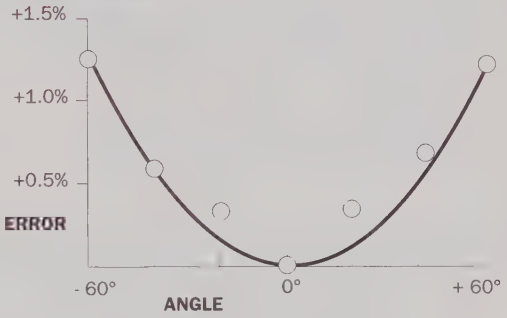
■ **Figure 11.1: Typical error vs. conductor position.** Based on the following test conditions:

- A-116 SmartProbe calibrated at 200 A, 60 Hz
- Error expressed as percent of reading
- Test at 16 A, 60 Hz
- Conductor perpendicular to plane of jaw
- Normalized to centered = 0.0%

Conductor Angle

The A-116 SmartProbe has its accuracy specified with the conductor positioned at 90° to the jaws. Figure 11-2 shows how the error varies with conductor angle.



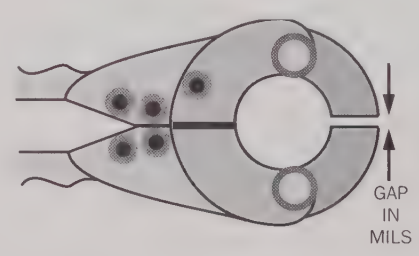


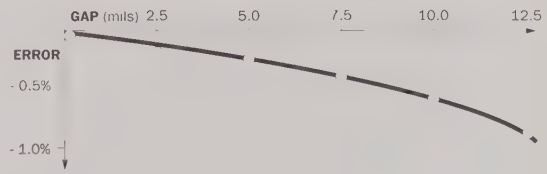
■ **Figure 11.2: Error vs. conductor angle**

- A-116 SmartProbe calibrated at 200 A, 60 Hz
- Error expressed as percent of reading
- Test at 20 A, 60 Hz
- Conductor passes through center point of jaw

Mating of Clamp-on Jaw

Errors will also be introduced if the jaws do not mate properly. Figure 11-3 shows how the error varies with the gap between the jaws of an A-116.

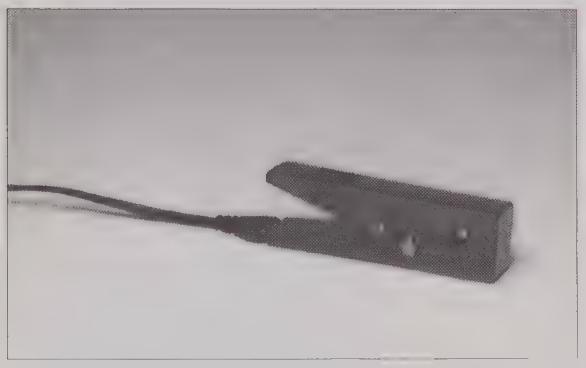




■ **Figure 11.3: Typical error vs. jaw gap**

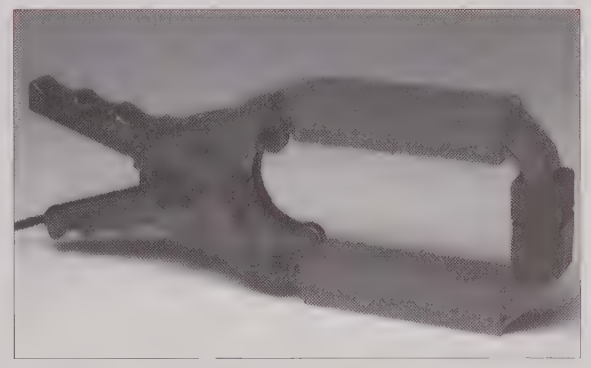
- A-116 SmartProbe calibrated at 200 A, 60 Hz
- Error expressed as a percent of reading
- Test at 16 A, 60 Hz, normalized to 0.0% at ø gap

SmartProbes



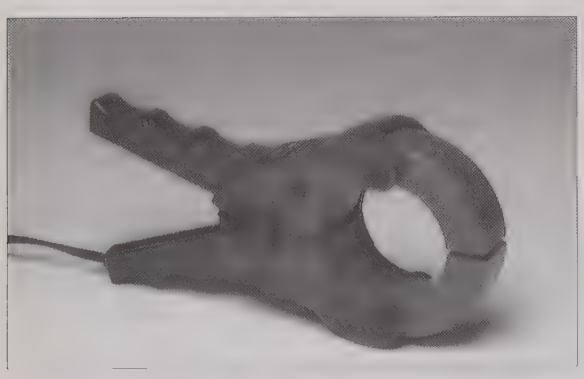
A-115
60 Amp AC Clamp-on SmartProbe
Use this clamp-on probe to take quick measurements of CTs and for monitoring individual loads up to 60 amps (individual branch circuits, personal computers, fractional horsepower motors, etc.).

Range: 1.0 - 60 A
Usable bandwidth: 45 - 1 kHz
Isolation: 3000 V
Max cable diameter: 0 .47 in (12 mm)



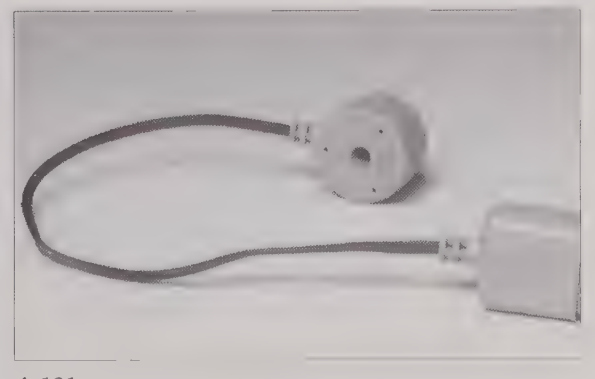
A-120
3000 Amp AC Clamp-on SmartProbe
Use this large probe for measuring high-current bus bars.

Range: 10 - 3000 A
Usable bandwidth: 30 - 3 kHz
Isolation: 4000 V
Jaw window: cable - 2.56 in (65 mm)
bus bar - 1.97 x 5.31 in (50 x 135 mm)
bus bar - 2.56 x 3.94 in (65 x 100 mm)



A-116
600 Amp AC Clamp-on SmartProbe
This is the general purpose current probe for most applications.

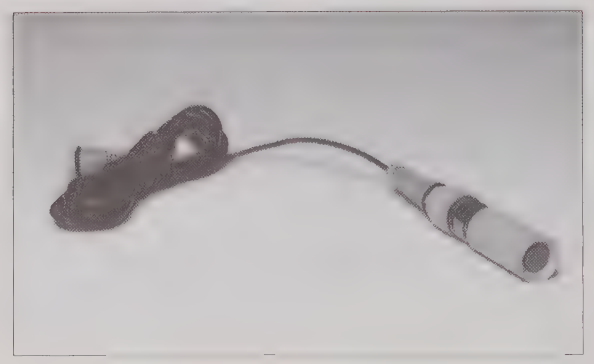
Working voltage: 600 V
Range: 1 - 600 A
Usable Bandwidth: 45 Hz - 3 kHz
Isolation: 2000 V
Max cable diameter: 2 in (54 mm)



A-121
Current Transformer Interface SmartProbe (CTIP)
A-121 includes open terminals to allow the user to add the needed interface.

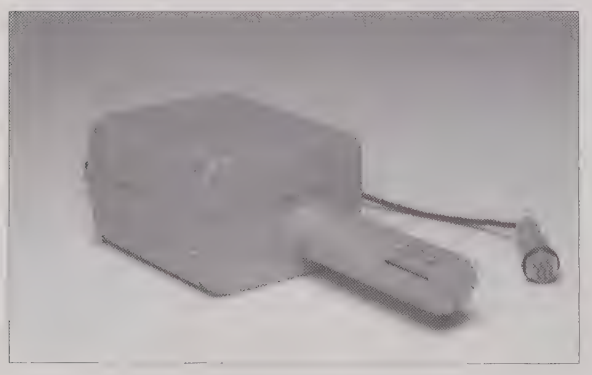
Range: 0.1 - 20 A (28 Apk)
Usable bandwidth: 50Hz - 3 kHz
Isolation: transformer

Environmental Probes



A-002
Temperature Probe
When your PowerScope is equipped with the A-002 Temperature Probe, it can graph both the ambient air temperature and the temperature rate-of-change. Use up to 8 probes at once for monitoring different areas or different cabinets within a computer room. Uses 1 PowerScope Environmental Channel

Range: 0°C - 100°C, and 1°C - 99°C per hour
32°F - 212 °F, and 1°F - 99°F per hour



A-003
Temperature/Humidity Probe
The A-003 Temperature/Humidity Probe lets your PowerScope print graphs of temperature, humidity, and their rate-of-change. This probe lets you clearly distinguish between system malfunctions caused by power faults from those cause by temperature and humidity disturbances.
Uses 1 PowerScope Environmental Channel

Range: 0°C - 80°C, and 1°C - 80°C per hour
32°F - 176°F, and 1°F - 99°F per hour
0 - 100%RH, & 1 - 99%RH per hour

A-007
Extension Cable for Temperature and Humidity Probes
Probes come with 10 foot (3 meter) cables. If you plan to monitor temperature or humidity in several locations with a single PowerScope, you'll want to use the A-007 Extension Cable with the A-002 Temperature Probe or A-003 Temperature/Humidity Probe. Length is 90 feet.

A-009
Contact Closure Probe
If you want to attach your PowerScope system to an alarm system, attention light, or other warning system, add an A-009 Contact Closure Probe. The A-009 provides a 2 second, NO (normally open) and NC (normally closed) contact closure whenever the PowerScope detects an out-of-tolerance condition.
Uses 1 PowerScope Environmental Channel
Contact ratings: 125 Vac @ 0.5 A, or 30 Vdc @ 2.0 A

A-111
AC/DC/Impulse Probe
The A-111 AC/DC/Impulse Probe extends the voltage capacity of the PowerScope and allows additional AC or DC channels to be added. The probe measures true RMS voltage for AC.

- Input range: 0-600 Vrms/Vdc; 0-2400 Vpk
- Typical accuracy (Vrms/Vdc): ±5% of reading
- Typical accuracy (Impulse): ±15% of reading
- Peak detector circuit: Reports top peak value, reset every second
- RMS and Vdc Thresholds/Full-scale ranges:

Vrms		Vdc	
Threshold	Full-scale range	Threshold	Full-scale range
1.1-15.0 Vrms	20.0 Vrms	1.0-7.0 Vdc	10.0 Vdc
15.1-130.0 Vrms	150.0 Vrms	7.1-17.0 Vdc	20.0 Vdc
130.1-260.0 Vrms	300.0 Vrms	17.1-99.0 Vdc	100.0 Vdc
260.1-600.0 Vrms	600.0 Vrms		

- Impulse Thresholds/Full-scale Ranges:

Vrms		Vdc	
Threshold	Full-scale range	Threshold	Full-scale range
8.0-80.0 Vpk	80.0 Vrms	4.0-40.0 Vpk	40.0 Vdc
60.0-600 Vpk	600.0 Vrms	8.0-80.0 Vpk	80.0 Vdc
120.0-1200.0 Vpk	1200.0 Vrms	40.0-400.0 Vpk	400.0 Vdc
240.0-2400.0 Vpk	2400.0 Vrms		

Supplies

A-010
The Handbook of PowerSignatures
The Handbook helps you interpret PowerScope graphs so you can solve power problems. Causes, symptoms, and solutions are set out for over 100 of the most common power disturbance signatures. It's organized by disturbance type for easy reference.

G-081
Carry Bag
A rugged canvas-type bag designed to carry your PowerScope, cables, and User's Guide.

S-801
Case of Thermal Paper
Don't get caught short. A case is 12 rolls. Remember to maintain the integrity and long life of your printer by using the recommended thermal paper.

G-801
Rugged Shipping Container
Ship your PowerScope safely. The 8800 PowerScope fits snuggly inside durable, pre-cut foam. International orange.

High Voltage Measurements
Your PowerScope can be equipped with standard external attenuators to monitor AC and DC voltages up to 35 KV; higher voltage attenuators can be specially ordered. For more information, contact Ross Engineering, 470 Westchester, Campbell, CA 95008 USA; phone 1-408-377-4621.

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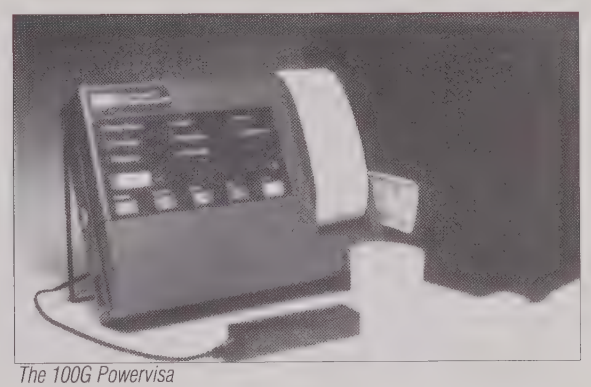
The 8010 PQNode

Remote monitoring with the PQNode

Functional, Flexible, Reliable Monitoring
The 8010 PQNode is a distributed hardware and software system for electric power and power disturbance monitoring. Basic technology from BMI's field-proven PowerScope and PowerProfiler portable instruments were incorporated into one package. These basic capabilities were then improved and expanded upon to provide a rugged package with superior performance for permanent or semipermanent power monitoring installations. The PQNode is designed to be used indoors or outdoors in a variety of locations, such as substations, pole-mounted applications, buildings, plants, and facilities feeders, or anywhere power quality is a concern.

The Electric Power Research Institute (EPRI) has installed PQNode modules at over 200 sites for the largest power quality survey conducted in the U.S. PQNode meets EPRI's rigid specifications, and it can meet yours. When it comes to disturbance analysis for improving power quality, you won't find a more flexible system, and one with more capabilities, than PQNode.



The 100G Powervisa

Working with the Powervisa

Partners in Power Problems
The BMI Powervisa is a power disturbance analyzer for single-phase power systems. It can be used as an introduction to power monitoring for those just getting started, or as a first-line tool in tracking down and solving power problems.

The Powervisa has no complicated connections. It measures voltage directly from its own AC power cord. The unit sets its own "automatic" thresholds, or the user can define a custom set for their own requirements. The user sets the country in which the Powervisa is monitoring, and the unit compares the power being provided to the country selected and uses the appropriate built-in automatic thresholds. An optional A-115 or A-116 SmartProbe can be connected for monitoring current.

The Powervisa 100G prints graphs and reports using a compatible format to the PowerScope. It prints using the same theory as the PowerScope: when a threshold is crossed, a disturbance graph or report is printed with time, date, duration, size, and all other relevant information included. The Powervisa provides summary reports of all disturbances recorded.

The Powervisa weighs less than 6 pounds and is sized to fit in a brief case or tool case (8½" x 11" x 2").

It makes an ideal tool for initial power monitoring on single-phase systems. Identify the power disturbances using the Powervisa, and then follow-up with the PowerScope to track the disturbances to their source through panels, circuits, and service entrances.

13 Other BMI Monitors

The 3030A PowerProfiler

The Demand Side of Your Electric Power

Using a PowerProfiler with Your PowerScope
Your PowerScope reports on all damaging power disturbances. And, with the harmonics option, helps you monitor and correct harmful harmonic problems. But when you need to know how much electric power is in use, where it gets used, and how much it costs you, the PowerProfiler can help.

Use it in conjunction with your PowerScope to fully characterize your electric power. Monitor usage, demand, cost, and more with the PowerProfiler, and watch for disturbances and problems with your PowerScope.

The PowerProfiler can be outfitted with a diskette drive that is compatible with the PowerScope diskette drive. This means you can take a diskette from a PowerScope and continue to record information to it on a PowerProfiler, and vice versa. Both PowerProfilers and PowerScopes are compatible with PowerTalk software, and graphs and reports from both units can be combined in PowerTalk to create professional looking reports and presentations.

Graph and report formats are compatible in that they both layout virtually the same, the information about the graph or report is presented the same, and the terminology and verbiage are consistent.

The units, however, are not capable of being connected together. Networks can be made of PowerScopes or PowerProfilers, but they cannot be combined. PowerTalk allows you to control both PowerScopes and PowerProfilers, and will assist you in bringing information from both products together for evaluation, analysis, and presentation.

Courses in Power Quality and Power Management

Expert Instruction
Electronic loads depend on clean power, and efficient operations depend on effective energy management. A thorough knowledge of electric power management, harmonics, and power monitoring equipment and techniques has become vital to meeting today's electrical needs.

The BMI Education Center has tailored courses to meet the needs of those just getting started with electric power and power monitoring, as well as experienced professionals and everyone in between. BMI courses are designed to provide classroom participation, hands-on laboratory work, and practical field experience. Students learn how to inspect power quality, diagnose problems, choose solutions, and effectively analyze and control energy use. All BMI courses are taught by professional instructors with extensive backgrounds in power management and power quality.

BMI courses are taught at our Education Center in California or can be brought to your facility. BMI will also customize courses to address your special needs.

Course Descriptions

Problem Solving with PowerScopes
Course 150, 2 days, or Course 151, 2 days
In each of these two day courses you will learn basic, as well as advanced skills in using the BMI PowerScopes. Extensive hands-on training in BMI's on-site lab will be emphasized. Tricks, troubleshooting, and monitoring techniques will be covered. Discussions on customizing reports for unique applications, as well as threshold settings, remote monitoring, use of PowerTalk software, and other options are included. No previous experience with BMI equipment is necessary. Basic knowledge of power distribution is required. Fee includes tuition, materials, and lunches.

The PowerProfiler: Use and Application
Course 155, 3 days
As a result of tighter energy budgets and higher energy costs, power measurement is more important than ever. However, due to the increase in electronic loads, power measurement is not as simple as it used to be. In this course, you will learn how to use state of the art technology by discussing the use and application of BMI's PowerProfilers. Definitions, power measurement, harmonics, energy costs, reporting, and use of PowerTalk software, as well as extensive hands-on training in BMI's on-site lab, will be covered. No previous experience with BMI equipment is necessary. Basic knowledge of power distribution is required. Fee includes tuition, materials, and lunches.

Power Quality for the Industry Professional
Course 170, 3 days
Learn to solve power quality problems in this course which combines classroom instruction with extensive hands-on training. Power distribution, troubleshooting techniques, use of instruments, disturbance theory, and data interpretation are covered in a fully equipped lab and in class discussion. We experiment with disturbance generators, loads, and power conditioning equipment and perform an actual step by step site survey. This course is designed for utility and field service engineers, facility and maintenance professionals, or others responsible for the delivery or end use of electric power in today's environment. An understanding of basic power distribution is required. Fee includes power reference library, tuition, and lunches.

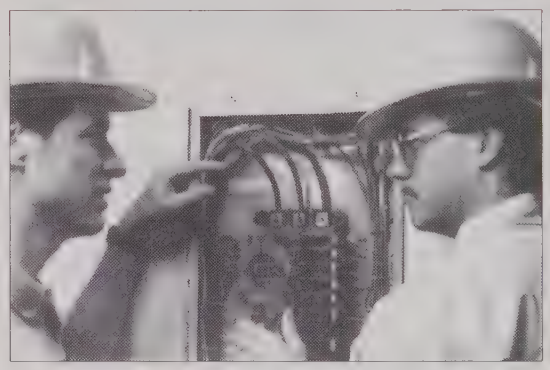
Advanced Power Quality Laboratory
Course 175, 2 days
In this two day lab class you will work with a complete range of power conditioning equipment, including spike supressors, isolation transformers, regulators, power conditioners, and UPS systems. The output of each device will be monitored and recorded while input is varied using variacs, Keytech impulse generators, and other disturbance sources. Graphic analysis skills will be enhanced by studying monitor reports. You will be able to observe how disturbances propagate through building systems when protected or unprotected. You will learn the particular characteristics of each technology and therefore be able to apply each intelligently. This course is designed for those already familiar with typical power problems and are seeking a more careful and comprehensive analysis of particular problems and equipment. Participants are encouraged to bring specific problems for class discussion. Fee includes tuition, materials, and lunches.

Power Management for the Industry Professional
Course 180, 2 days
Learn the efficient, practical, and effective way to control electrical power cost in this course which combines classroom instruction with extensive hands-on training. You will learn about power distribution, utility rate making and billing methods, methods for improving electrical equipment efficiency, taking advantage of time of use rate

structure, demand limiting, power factor improvement, and the psychology of energy conservation. Modeling energy systems will be discussed, as well as the economics of energy management, life cycle costs, and return on investment. Empirical studies will be emphasized and compared with rule of thumb or name plate data calculation. Measurement techniques will be practiced in the lab and a typical facility. An understanding of basic electricity is required. Fee includes power reference library, tuition, and lunches.

End Use Power Line Harmonics
In this intensive seminar you will be introduced to the phenomena of power line harmonics. Their source and effects on the power system will be presented as well as the most typical problems and solutions. Subjects covered include the Fourier Series analysis, voltage versus current harmonics, neutral conductor overloading, parallel and series resonance problems, filter applications, transformer derating, measurement, and standards. An understanding of basic power distribution is required. This course is presented around the world throughout the year. Fee covers tuition, materials, and lunch.

Course dates, length, and price varies. Contact BMI for details.



The PowerCoach

One-on-One Training
In many cases, the best way to learn about power quality and power management is to turn your own problem or necessity into a learning experience. This is the philosophy behind the BMI PowerCoach.

The PowerCoach is a contract service that brings a BMI power professional to your location. The PowerCoach works with you to solve your problem while teaching you and your co-workers or peers how to do it on your own. You use your equipment, in your facility, on your power.

The concept is one-on-one training. You contract the PowerCoach to work with you at your pace. You'll learn how to interpret data, track down problems, identify symptoms, causes, and solutions. The PowerCoach can even show you how to conduct a complete site survey, from demand and cash flow, to harmonics, and power quality.

One of the most important parts of the PowerCoach experience is that you learn to use sophisticated power monitoring equipment. If you already own equipment, the PowerCoach can teach you to use it, use it more efficiently, or put it to better use. If you don't own power monitoring equipment, the PowerCoach can bring it with him, compare makes and models, and even recommend equipment for your application.

Contact the BMI Education Center to contract a PowerCoach. They can quote you fees, expenses, and schedules.

Technical Support and Applications Assistance

Just a Phone Call Away

Many questions can come up while you're working with your BMI PowerScope. How do I connect for a specific application? Why can't I get the stripcharts to print? How can I complete a connection using modems and PowerTalk?

If the question is unusual, or isn't answered in this User's Guide, contact BMI Technical Support. A team of support personnel is available Monday through Friday, 7:00 AM to 5:00 PM PST. They can answer your questions, provide support and assistance, and generally help out. This service is available to BMI customers free of charge.

Data Interpretation

BMI is also happy to provide data interpretation for our customers. If you're having trouble making sense of your graphs or reports, or have information on a problem you haven't seen before, you can fax in your graphs and reports to BMI Customer Service and we'll get back to you.

Equipment Service, Maintenance, and Calibration

BMI's Customer Service Department handles all service, repair, maintenance, and calibration for BMI units. A call to Customer Service will help you diagnose a problem with your unit, determine the need for repair or service, or arrange for calibration. A sophisticated tracking system maintains records on your unit(s), ship dates, services dates, warranty information, and other items that help our Customer Service Representatives respond to your needs.

When returning a unit to BMI for any reason, contact Customer Service for a return authorization (RA) number before shipping the unit. This allows the Customer Service Representative to talk to you about the problem, diagnose the problem, and perhaps even tell you have to fix it in the field. This also allows Customer Service Representative to update your records, prepare incoming paperwork, and schedule the unit for the necessary work. From time to time, BMI upgrades the operating software within the units. The Customer Service Representative can tell you about these upgrades and arrange for them to be done while your unit is with BMI.

The Customer Service Representative can also arrange to add options to your unit. If you want to add the Storage Option Package, the Communications Option Package, or the Harmonic Option Package, the Representative can arrange for the return of the unit to the factory, and the subsequent shipping of the unit back to you.

How to Contact BMI

Use the phone and fax numbers below to contact BMI, Customer Service Representatives, the Education Department, or Sales.

Main Telephone	800 876-5355 408 970-3700
FAX	408 970-3720

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Storing Thresholds to Memory

Preset Thresholds
PowerScopes leave the factory with preset thresholds (or default values) already in memory. These thresholds are based on the most common power systems used and the voltage setting for the PowerScope itself. While the preset thresholds cannot be changed by the user, customized thresholds can be entered in one or more of the three memories available.

The Store Memory Button
Every PowerScope is equipped with three independent user memories. These memories store the customized threshold information entered by the user. Each memory also holds the setup and key operator information in use when the thresholds are committed to memory.

The three memories are especially helpful for programming in the information for your most common applications and accessing this information in just a few keystrokes. When you committ thresholds to memory by pressing the **Store Memory** button, you are also committing all the setup information, key opeator information, and report information you have entered or selected. Therefore, by entering in site name, report type and intervals, operating parameters, andso on, as well as your customized thresholds, then pressing **Store Memory** and selecting the memory number, your are creating a full monitoring environment.

Recalling a Memory
To recall the information stored to a memory and use it for your monitoring session, use the **Recall Memory** button. You can select from the three user-defined memories or the default settings.

When you select the default settings, the PowerScope will return to the default settings for the country the unit was shipped to.

To Store Your Settings to Memory

1. Enter all of your session information using the Setup Menu, Key Operator Menu, and Report Menu.

2. Press **Store Memory**. The display window will read [Store Mem:].

3. Use the **Value Up/Value Down** buttons to position the desired memory in which you will store your settings. Your selections are *Memory #1, Memory #2, Memory #3,* and *Quit.*

4. Press the **Scroll Down** arrow to committ your settings to the selected memory. If you choose Quit, nothing will be stored.

If one or all of the memories is missing from the selections, it's because they are protected with a Read Only setting in the Key Operator Menu (see Key Operator Menu, Chapter 5, page 5-7).

You can also name the three memories in the Key Operator Menu. If you have named a memory, it will appear in the selections using the assigned name instead of the preassigned memory number.

To Recall and Use a Memory

1. Press **Recall Memory**. The display window will read [Recall Mem:].

2. Use the **Value Up/Value Down** buttons to select the memory you wish to recall and use.

3. Press the **Scroll Down** arrow to recall and use the selected memory. If you select *Preset Threshold,* all default settings for single-phase power will be restored. If you choose *Quit,* nothing will be recalled and your present setup won't be disturbed.

Need Help? Call (408) 970-3700, or Fax (408) 970-3720 ◆

15 Thresholds

Recommended Thresholds

Use these thresholds to get started only if you lack other data about acceptable power for your application.

Country	Nominal Power		Recommended BMI PowerScope Thresholds			
	Voltage	Frequency	Frequency Tolerance	Surge	Sag	Impulse
Abu Dhabi	240 Vrms	50 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
	415 Vrms	50 Hz	1.0 Hz	457 Vrms	352 Vrms	600 Vpk
Afghanistan	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	414 Vrms	323 Vrms	600 Vpk
Algeria	127 Vrms	50 Hz	0.8 Hz	140 Vrms	114 Vrms	200 Vpk
	220 Vrms	50 Hz	0.8 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.8 Hz	419 Vrms	323 Vrms	600 Vpk
Angola	220 Vrms	50 Hz	1.0 Hz	243 Vrms	184 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Antigua	230 Vrms	60 Hz	1.2 Hz	254 Vrms	195 Vrms	700 Vpk
	400 Vrms	60 Hz	1.2 Hz	441 Vrms	340 Vrms	600 Vpk
Argentina	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
	390 Vrms	50 Hz	0.5 Hz	430 Vrms	451 Vrms	700 Vpk
Australia	240 Vrms	50 Hz	0.5 Hz	255 Vrms	225 Vrms	400 Vpk
	415 Vrms	50 Hz	0.5 Hz	440 Vrms	390 Vrms	600 Vpk
	440 Vrms	50 Hz	0.5 Hz	467 Vrms	413 Vrms	700 Vpk
Austria	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk
Azores	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk
Bahamas	120 Vrms	60 Hz	1.2 Hz	133 Vrms	102 Vrms	200 Vpk
	208 Vrms	60 Hz	1.2 Hz	229 Vrms	176 Vrms	300 Vpk
	240 Vrms	60 Hz	1.2 Hz	265 Vrms	204 Vrms	400 Vpk
	415 Vrms	60 Hz	1.2 Hz	457 Vrms	352 Vrms	600 Vpk
Bahrain	120 Vrms	50 Hz	1.0 Hz	117 Vrms	103 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	234 Vrms	206 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	403 Vrms	375 Vrms	600 Vpk
	400 Vrms	50 Hz	1.0 Hz	425 Vrms	376 Vrms	600 Vpk
	110 Vrms	60 Hz	1.2 Hz	117 Vrms	103 Vrms	200 Vpk
	220 Vrms	60 Hz	1.2 Hz	234 Vrms	206 Vrms	400 Vpk
	380 Vrms	60 Hz	1.2 Hz	403 Vrms	357 Vrms	600 Vpk
	400 Vrms	60 Hz	1.2 Hz	425 Vrms	376 Vrms	600 Vpk
Bangledesh	230 Vrms	50 Hz	2.0 Hz	242 Vrms	218 Vrms	400 Vpk
	400 Vrms	50 Hz	2.0 Hz	421 Vrms	380 Vrms	600 Vpk
Barbados	115 Vrms	50 Hz	1.0 Hz	127 Vrms	97 Vrms	200 Vpk
Belguim	220 Vrms	50 Hz	0.5 Hz	243 Vrms	187 Vrms	400 Vpk
	240 Vrms	50 Hz	0.5 Hz	255 Vrms	194 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	323 Vrms	600 Vpk
	400 Vrms	50 Hz	0.5 Hz	441 Vrms	324 Vrms	600 Vpk
	415 Vrms	50 Hz	0.5 Hz	440 Vrms	336 Vrms	600 Vpk
Benin	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Bermuda	120 Vrms	60 Hz	0.6 Hz	153 Vrms	102 Vrms	200 Vpk
	208 Vrms	60 Hz	1.0 Hz	229 Vrms	176 Vrms	300 Vpk
Bolivia	110 Vrms	50 Hz	1.0 Hz	122 Vrms	93 Vrms	200 Vpk
Botswana	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Brazil	110 Vrms	60 Hz	1.2 Hz	122 Vrms	93 Vrms	200 Vpk
	127 Vrms	60 Hz	1.2 Hz	140 Vrms	107 Vrms	200 Vpk
	220 Vrms	60 Hz	1.2 Hz	243 Vrms	187 Vrms	400 Vpk
Brunei	240 Vrms	50 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
Bulgaria	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Burma	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Burundi	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Cambodia	120 Vrms	50 Hz	1.0 Hz	133 Vrms	102 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Cameroon	127 Vrms	50 Hz	1.0 Hz	140 Vrms	107 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk

Recommended Thresholds

Use these thresholds to get started only if you lack other data about acceptable power for your application.

Country	Nominal Power		Recommended BMI PowerScope Thresholds			
	Voltage	Frequency	Frequency Tolerance	Surge	Sag	Impulse
Canada	120 Vrms	60 Hz	0.6 Hz	125 Vrms	110 Vrms	200 Vpk
	208 Vrms	60 Hz	0.6 Hz	217 Vrms	190 Vrms	300 Vpk
	240 Vrms	60 Hz	0.6 Hz	250 Vrms	220 Vrms	400 Vpk
	347 Vrms	60 Hz	0.6 Hz	361 Vrms	318 Vrms	500 Vpk
	480 Vrms	60 Hz	0.6 Hz	500 Vrms	440 Vrms	700 Vpk
	600 Vrms	60 Hz	0.6 Hz	625 Vrms	550 Vrms	900 Vpk
Canary Is.	127 Vrms	50 Hz	1.0 Hz	140 Vrms	107 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Cayman Is.	120 Vrms	60 Hz	0.6 Hz	133 Vrms	108 Vrms	200 Vpk
	208 Vrms	60 Hz	0.6 Hz	229 Vrms	187 Vrms	300 Vpk
	227 Vrms	60 Hz	0.6 Hz	250 Vrms	204 Vrms	400 Vpk
	240 Vrms	60 Hz	0.6 Hz	265 Vrms	216 Vrms	400 Vpk
	480 Vrms	60 Hz	0.6 Hz	529 Vrms	432 Vrms	700 Vpk
Cent. Afr. Rep.	220 Vrms	50 Hz	0.1 Hz	243 Vrms	187 Vrms	400 Vpk
Chad	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Chile	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
China	220 Vrms	50 Hz	1.0 Hz	236 Vrms	204 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	407 Vrms	353 Vrms	600 Vpk
Columbia	120 Vrms	60 Hz	0.6 Hz	133 Vrms	108 Vrms	200 Vpk
	240 Vrms	60 Hz	0.6 Hz	265 Vrms	216 Vrms	400 Vpk
Congo	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Costa Rica	120 Vrms	60 Hz	1.2 Hz	133 Vrms	102 Vrms	200 Vpk
	240 Vrms	60 Hz	1.2 Hz	265 Vrms	204 Vrms	400 Vpk
Cuba	120 Vrms	60 Hz	1.2 Hz	133 Vrms	102 Vrms	200 Vpk
Cyprus	115 Vrms	50 Hz	1.3 Hz	122 Vrms	108 Vrms	200 Vpk
	240 Vrms	50 Hz	1.3 Hz	255 Vrms	225 Vrms	400 Vpk
Czechoslovakia	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
Dahomy	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
Denmark	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
Dominica	230 Vrms	50 Hz	1.0 Hz	254 Vrms	195 Vrms	400 Vpk
	400 Vrms	50 Hz	1.0 Hz	441 Vrms	340 Vrms	600 Vpk
Dominican Rep.	110 Vrms	60 Hz	1.2 Hz	122 Vrms	93 Vrms	200 Vpk
	220 Vrms	60 Hz	1.2 Hz	243 Vrms	187 Vrms	400 Vpk
Dubai	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Ecuador	110 Vrms	60 Hz	1.2 Hz	122 Vrms	93 Vrms	200 Vpk
	120 Vrms	60 Hz	1.2 Hz	133 Vrms	98 Vrms	200 Vpk
	208 Vrms	60 Hz	1.2 Hz	229 Vrms	176 Vrms	300 Vpk
	220 Vrms	60 Hz	1.2 Hz	243 Vrms	187 Vrms	400 Vpk
	240 Vrms	60 Hz	1.2 Hz	265 Vrms	204 Vrms	400 Vpk
Egypt	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
El Salvador	120 Vrms	60 Hz	0.6 Hz	127 Vrms	114 Vrms	200 Vpk
	240 Vrms	60 Hz	0.6 Hz	253 Vrms	228 Vrms	400 Vpk
Ethiopia	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Falkland Is.	230 Vrms	50 Hz	1.5 Hz	236 Vrms	224 Vrms	400 Vpk
	415 Vrms	50 Hz	1.5 Hz	426 Vrms	404 Vrms	600 Vpk
Fiji Is.	240 Vrms	50 Hz	0.5 Hz	265 Vrms	204 Vrms	400 Vpk
	415 Vrms	50 Hz	0.5 Hz	457 Vrms	352 Vrms	600 Vpk
Finland	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
	660 Vrms	50 Hz	0.5 Hz	727 Vrms	594 Vrms	1000 Vpk

15 Thresholds

Recommended Thresholds

Use these thresholds to get started only if you lack other data about acceptable power for your application.

Country	Nominal Power		Recommended BMI PowerScope Thresholds			
	Voltage	Frequency	Frequency Tolerance	Surge	Sag	Impulse
France	127 Vrms	50 Hz	0.5 Hz	140 Vrms	114 Vrms	200 Vpk
	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
French Guiana	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Gabon	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Gambia	230 Vrms	50 Hz	1.0 Hz	242 Vrms	218 Vrms	400 Vpk
	400 Vrms	50 Hz	1.0 Hz	421 Vrms	380 Vrms	600 Vpk
Germany	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
Germany	127 Vrms	50 Hz	0.5 Hz	134 Vrms	120 Vrms	200 Vpk
(D.Rep.)	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk
	660 Vrms	50 Hz	0.5 Hz	694 Vrms	627 Vrms	1000 Vpk
Ghana	250 Vrms	50 Hz	2.5 Hz	276 Vrms	225 Vrms	400 Vpk
	440 Vrms	50 Hz	0.5 Hz	485 Vrms	396 Vrms	700 Vpk
Gibraltar	240 Vrms	50 Hz	0.5 Hz	255 Vrms	225 Vrms	400 Vpk
	415 Vrms	50 Hz	0.5 Hz	440 Vrms	390 Vrms	600 Vpk
Greece	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk
Greenland	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Grenada	230 Vrms	50 Hz	1.0 Hz	254 Vrms	195 Vrms	400 Vpk
Guadeloupe	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
	220 Vrms	60 Hz	1.2 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	60 Hz	1.2 Hz	419 Vrms	323 Vrms	600 Vpk
Guam	120 Vrms	60 Hz	0.6 Hz	130 Vrms	108 Vrms	200 Vpk
	208 Vrms	60 Hz	0.6 Hz	225 Vrms	187 Vrms	300 Vpk
	227 Vrms	60 Hz	0.6 Hz	246 Vrms	204 Vrms	400 Vpk
	240 Vrms	60 Hz	0.6 Hz	260 Vrms	216 Vrms	400 Vpk
	480 Vrms	60 Hz	0.6 Hz	519 Vrms	432 Vrms	700 Vpk
Guatemala	120 Vrms	60 Hz	1.0 Hz	133 Vrms	108 Vrms	200 Vpk
	240 Vrms	60 Hz	1.0 Hz	265 Vrms	216 Vrms	400 Vpk
Guyana	110 Vrms	50 Hz	1.0 Hz	122 Vrms	93 Vrms	200 Vpk
	240 Vrms	50 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
	110 Vrms	60 Hz	1.2 Hz	122 Vrms	93 Vrms	200 Vpk
	240 Vrms	60 Hz	1.2 Hz	265 Vrms	204 Vrms	400 Vpk
Haiti	115 Vrms	60 Hz	1.2 Hz	127 Vrms	97 Vrms	200 Vpk
	220 Vrms	60 Hz	1.2 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	60 Hz	1.2 Hz	419 Vrms	323 Vrms	600 Vpk
Honduras	110 Vrms	60 Hz	1.2 Hz	122 Vrms	93 Vrms	200 Vpk
	220 Vrms	60 Hz	1.2 Hz	243 Vrms	187 Vrms	400 Vpk
Hong Kong	200 Vrms	50 Hz	1.0 Hz	213 Vrms	188 Vrms	300 Vpk
	220 Vrms	50 Hz	1.0 Hz	234 Vrms	206 Vrms	400 Vpk
	346 Vrms	50 Hz	1.0 Hz	367 Vrms	325 Vrms	500 Vpk
	380 Vrms	50 Hz	1.0 Hz	403 Vrms	357 Vrms	600 Vpk
	346 Vrms	50 Hz	1.0 Hz	367 Vrms	325 Vrms	500 Vpk
	380 Vrms	50 Hz	1.0 Hz	403 Vrms	357 Vrms	600 Vpk
Hungary	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	400 Vrms	342 Vrms	600 Vpk
Iceland	220 Vrms	50 Hz	0.5 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	323 Vrms	600 Vpk
India	230 Vrms	50 Hz	1.5 Hz	240 Vrms	220 Vrms	400 Vpk
	250 Vrms	50 Hz	1.5 Hz	261 Vrms	240 Vrms	400 Vpk
	400 Vrms	50 Hz	1.5 Hz	417 Vrms	384 Vrms	600 Vpk
	440 Vrms	50 Hz	1.5 Hz	458 Vrms	422 Vrms	700 Vpk
Indonesia	127 Vrms	50 Hz	0.5 Hz	134 Vrms	120 Vrms	200 Vpk
	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk

Recommended Thresholds

Use these thresholds to get started only if you lack other data about acceptable power for your application.

Country	Nominal Power		Recommended BMI PowerScope Thresholds			
	Voltage	Frequency	Frequency Tolerance	Surge	Sag	Impulse
Iran	220 Vrms	50 Hz	2.5 Hz	254 Vrms	187 Vrms	400 Vpk
	231 Vrms	50 Hz	2.5 Hz	266 Vrms	196 Vrms	400 Vpk
	380 Vrms	50 Hz	2.5 Hz	438 Vrms	323 Vrms	600 Vpk
	400 Vrms	50 Hz	2.5 Hz	461 Vrms	340 Vrms	600 Vpk
Iraq	220 Vrms	50 Hz	1.0 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk
Ireland	220 Vrms	50 Hz	0.5 Hz	234 Vrms	206 Vrms	400 Vpk
	230 Vrms	50 Hz	0.5 Hz	244 Vrms	216 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	403 Vrms	357 Vrms	600 Vpk
	400 Vrms	50 Hz	0.5 Hz	425 Vrms	376 Vrms	600 Vpk
Israel	230 Vrms	50 Hz	1.0 Hz	244 Vrms	216 Vrms	400 Vpk
	400 Vrms	50 Hz	1.0 Hz	425 Vrms	376 Vrms	600 Vpk
Italy	127 Vrms	50 Hz	0.5 Hz	140 Vrms	114 Vrms	200 Vpk
	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
Ivory Coast	220 Vrms	50 Hz	1.0 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Jamaica	110 Vrms	50 Hz	0.5 Hz	117 Vrms	103 Vrms	200 Vpk
	220 Vrms	50 Hz	0.5 Hz	234 Vrms	206 Vrms	400 Vpk
Japan (East)	100 Vrms	50 Hz	0.5 Hz	111 Vrms	90 Vrms	200 Vpk
	200 Vrms	50 Hz	0.5 Hz	221 Vrms	180 Vrms	300 Vpk
Japan (West)	100 Vrms	60 Hz	0.6 Hz	111 Vrms	90 Vrms	200 Vpk
	200 Vrms	60 Hz	0.6 Hz	221 Vrms	180 Vrms	300 Vpk
Jordan	100 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Kenya	240 Vrms	50 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
	415 Vrms	50 Hz	1.0 Hz	457 Vrms	352 Vrms	600 Vpk
Korea (North)	220 Vrms	50 Hz	1.2 Hz	235 Vrms	190 Vrms	400 Vpk
	380 Vrms	50 Hz	1.2 Hz	406 Vrms	328 Vrms	600 Vpk
Korea (South)	100 Vrms	60 Hz	1.0 Hz	111 Vrms	85 Vrms	200 Vpk
	200 Vrms	60 Hz	1.0 Hz	221 Vrms	170 Vrms	300 Vpk
	240 Vrms	60 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
	415 Vrms	60 Hz	1.0 Hz	457 Vrms	352 Vrms	600 Vpk
Laos	220 Vrms	50 Hz	4.0 Hz	234 Vrms	206 Vrms	400 Vpk
	380 Vrms	50 Hz	4.0 Hz	403 Vrms	357 Vrms	600 Vpk
Lebanon	110 Vrms	50 Hz	1.0 Hz	122 Vrms	93 Vrms	200 Vpk
	190 Vrms	50 Hz	1.0 Hz	210 Vrms	161 Vrms	300 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Lesotho	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Liberia	120 Vrms	60 Hz	2.0 Hz	123 Vrms	117 Vrms	200 Vpk
	208 Vrms	60 Hz	2.0 Hz	212 Vrms	204 Vrms	300 Vpk
	240 Vrms	60 Hz	2.0 Hz	245 Vrms	235 Vrms	400 Vpk
	416 Vrms	60 Hz	2.0 Hz	424 Vrms	408 Vrms	600 Vpk
Libya	127 Vrms	50 Hz	1.0 Hz	140 Vrms	107 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	400 Vrms	50 Hz	1.0 Hz	441 Vrms	340 Vrms	600 Vpk
Luxembourg	120 Vrms	50 Hz	0.5 Hz	133 Vrms	108 Vrms	200 Vpk
	208 Vrms	50 Hz	0.5 Hz	229 Vrms	187 Vrms	300 Vpk
	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
Malagasy	127 Vrms	50 Hz	1.0 Hz	131 Vrms	123 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	227 Vrms	213 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	392 Vrms	368 Vrms	600 Vpk
Malawi	230 Vrms	50 Hz	1.0 Hz	254 Vrms	195 Vrms	400 Vpk
	400 Vrms	50 Hz	1.0 Hz	441 Vrms	340 Vrms	600 Vpk

15 Thresholds

Recommended Thresholds

Use these thresholds to get started only if you lack other data about acceptable power for your application.

Country	Nominal Power		Recommended BMI PowerScope Thresholds			
	Voltage	Frequency	Frequency Tolerance	Surge	Sag	Impulse
Malaysia	240 Vrms	50 Hz	0.5 Hz	253 Vrms	216 Vrms	400 Vpk
	415 Vrms	50 Hz	0.5 Hz	436 Vrms	373 Vrms	600 Vpk
Mali	127 Vrms	50 Hz	1.0 Hz	140 Vrms	107 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Malta	240 Vrms	50 Hz	0.5 Hz	265 Vrms	204 Vrms	400 Vpk
	415 Vrms	50 Hz	0.5 Hz	457 Vrms	352 Vrms	600 Vpk
Martinique	127 Vrms	50 Hz	1.0 Hz	140 Vrms	107 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Mauritania	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Mauritius	230 Vrms	50 Hz	0.5 Hz	244 Vrms	216 Vrmas	400 Vpk
	400 Vrms	50 Hz	0.5 Hz	425 Vrms	376 Vrms	600 Vpk
Mexico	127 Vrms	60 Hz	1.2 Hz	135 Vrms	119 Vrms	200 Vpk
	220 Vrms	50 Hz	1.2 Hz	234 Vrms	206 Vrms	400 Vpk
	277 Vrms	60 Hz	1.2 Hz	294 Vrms	260 Vrms	400 Vpk
	480 Vrms	60 Hz	1.2 Hz	509 Vrms	451 Vrms	700 Vpk
Monaco	127 Vrms	50 Hz	1.0 Hz	140 Vrms	107 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Montserrat	230 Vrms	60 Hz	1.2 Hz	254 Vrms	195 Vrms	400 Vpk
	400 Vrms	60 Hz	1.2 Hz	441 Vrms	340 Vrms	600 Vpk
Morocco	115 Vrms	50 Hz	1.0 Hz	127 Vrms	97 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Mozambique	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Nambia	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Nepal	220 Vrms	50 Hz	0.5 Hz	243 Vrms	187 Vrms	400 Vpk
	400 Vrms	50 Hz	0.5 Hz	441 Vrms	360 Vrms	600 Vpk
Netherlands	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
Nethantilles	115 Vrms	50 Hz	1.0 Hz	127 Vrms	97 Vrms	200 Vpk
New Guinea	240 Vrms	50 Hz	1.0 Hz	253 Vrms	228 Vrms	400 Vpk
	415 Vrms	50 Hz	1.0 Hz	436 Vrms	394 Vrms	600 Vpk
New Zealand	230 Vrms	50 Hz	0.8 Hz	242 Vrms	218 Vrms	400 Vpk
	400 Vrms	50 Hz	0.8 Hz	421 Vrms	380 Vrms	600 Vpk
	415 Vrms	50 Hz	0.8 Hz	436 Vrms	394 Vrms	600 Vpk
	440 Vrms	50 Hz	0.8 Hz	463 Vrms	418 Vrms	700 Vpk
Nicaragua	120 Vrms	60 Hz	1.2 Hz	133 Vrms	102 Vrms	200 Vph
	240 Vrms	60 Hz	1.2 Hz	265 Vrms	204 Vrms	400 Vpk
Niger	220 Vrms	50 Hz	1.2 Hz	133 Vrms	102 Vrms	200 Vpk
	380 Vrms	50 Hz	0.5 Hz	390 Vrms	370 Vrms	600 Vpk
Nigeria	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	230 Vrms	50 Hz	0.5 Hz	242 Vrms	195 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	323 Vrms	600 Vpk
	400 Vrms	50 Hz	0.5 Hz	421 Vrms	340 Vrms	600 Vpk
Norway	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
Oman	240 Vrms	50 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
	415 Vrms	50 Hz	1.0 Hz	457 Vrms	352 Vrms	600 Vpk
Pakistan	230 Vrms	50 Hz	1.0 Hz	254 Vrms	195 Vrms	400 Vpk
	400 Vrms	50 Hz	1.0 Hz	441 Vrms	340 Vrms	600 Vpk
Panama	120 Vrms	60 Hz	0.6 Hz	127 Vrms	114 Vrms	200 Vpk
	240 Vrms	60 Hz	0.6 Hz	253 Vrms	228 Vrms	400 Vpk
	277 Vrms	60 Hz	0.6 Hz	291 Vrms	263 Vrms	400 Vpk
	480 Vrms	60 Hz	0.6 Hz	505 Vrms	456 Vrms	700 Vpk
Paraguay	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
	440 Vrms	50 Hz	1.0 Hz	485 Vrms	374 Vrms	700 Vpk

Recommended Thresholds

Use these thresholds to get started only if you lack other data about acceptable power for your application.

Country	Nominal Power		Recommended BMI PowerScope Thresholds			
	Voltage	Frequency	Frequency Tolerance	Surge	Sag	Impulse
Peru	225 Vrms	60 Hz	1.2 Hz	248 Vrms	191 Vrms	400 Vpk
Philippines	110 Vrms	60 Hz	0.6 Hz	116 Vrms	104 Vrms	200 Vpk
	220 Vrms	60 Hz	0.6 Hz	232 Vrms	209 Vrms	400 Vpk
Poland	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk
Portugal	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk
Puerto Rico	120 Vrms	60 Hz	0.6 Hz	133 Vrms	108 Vrms	200 Vpk
	240 Vrms	60 Hz	0.5 Hz	265 Vrms	216 Vrms	400 Vpk
	480 Vrms	60 Hz	0.6 Hz	529 Vrms	432 Vrms	700 Vpk
Qatar	240 Vrms	50 Hz	1.0 Hz	255 Vrms	225 Vrms	400 Vpk
	415 Vrms	50 Hz	1.0 Hz	440 Vrms	390 Vrms	600 Vpk
Romania	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk
Rwanda	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk
St. Helena	230 Vrms	50 Hz	1.0 Hz	254 Vrms	195 Vrms	400 Vpk
St. Kitts-Nevis	230 Vrms	60 Hz	1.2 Hz	254 Vrms	195 Vrms	400 Vpk
	400 Vrms	60 Hz	1.2 Hz	441 Vrms	340 Vrms	600 Vpk
St. Lucia	240 Vrms	50 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
	415 Vrms	50 Hz	1.0 Hz	457 Vrms	352 Vrms	600 Vpk
St. Vincent	230 Vrms	50 Hz	1.0 Hz	254 Vrms	195 Vrms	400 Vpk
	400 Vrms	50 Hz	1.0 Hz	441 Vrms	340 Vrms	600 Vpk
Saudia Arabia	127 Vrms	50 Hz	0.5 Hz	134 Vrms	120 Vrms	200 Vpk
	220 Vrms	50 Hz	0.5 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	400 Vrms	361 Vrms	600 Vpk
	127 Vrms	60 Hz	0.6 Hz	134 Vrms	120 Vrms	200 Vpk
	220 Vrms	60 Hz	0.6 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	60 Hz	0.6 Hz	400 Vrms	361 Vrms	600 Vpk
Senegal	127 Vrms	50 Hz	1.0 Hz	140 Vrms	107 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Seychelles	240 Vrms	50 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
Sierra Leone	230 Vrms	50 Hz	1.0 Hz	254 Vrms	195 Vrms	400 Vpk
Singapore	230 Vrms	50 Hz	0.5 Hz	237 Vrms	223 Vrms	400 Vpk
	400 Vrms	50 Hz	0.5 Hz	413 Vrms	388 Vrms	600 Vpk
Solomon Is.	240 Vrms	50 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
Somalia Rep.	110 Vrms	50 Hz	1.0 Hz	122 Vrms	93 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	440 Vrms	50 Hz	1.0 Hz	485 Vrms	374 Vrms	700 Vpk
South Africa	220 Vrms	50 Hz	1.3 Hz	232 Vrms	209 Vrms	400 Vpk
	250 Vrms	50 Hz	1.3 Hz	263 Vrms	237 Vrms	400 Vpk
	380 Vrms	50 Hz	1.3 Hz	400 Vrms	361 Vrms	600 Vpk
	400 Vrms	50 Hz	1.3 Hz	421 Vrms	380 Vrms	600 Vpk
	433 Vrms	50 Hz	1.3 Hz	455 Vrms	411 Vrms	700 Vpk
	500 Vrms	50 Hz	1.3 Hz	526 Vrms	475 Vrms	800 Vpk
Spain	127 Vrms	50 Hz	1.5 Hz	136 Vrms	118 Vrms	200 Vpk
	220 Vrms	50 Hz	1.5 Hz	236 Vrms	204 Vrms	400 Vpk
	380 Vrms	50 Hz	1.5 Hz	407 Vrms	353 Vrms	600 Vpk
Sri Lanka	230 Vrms	50 Hz	1.0 Hz	244 Vrms	216 Vrms	400 Vpk
	400 Vrms	50 Hz	1.0 Hz	425 Vrms	375 Vrms	600 Vpk
Sudan	240 Vrms	50 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
	415 Vrms	50 Hz	1.0 Hz	457 Vrms	352 Vrms	600 Vpk
Surinam	115 Vrms	50 Hz	1.0 Hz	127 Vrms	97 Vrms	200 Vpk
	127 Vrms	50 Hz	1.0 Hz	140 Vrms	107 Vrms	200 Vpk

15 Thresholds

Recommended Thresholds

Use these thresholds to get started only if you lack other data about acceptable power for your application.

Country	Nominal Power		Recommended BMI PowerScope Thresholds			
	Voltage	Frequency	Frequency Tolerance	Surge	Sag	Impulse
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	115 Vrms	60 Hz	1.2 Hz	127 Vrms	97 Vrms	200 Vpk
	127 Vrms	60 Hz	1.2 Hz	140 Vrms	107 Vrms	200 Vpk
	220 Vrms	60 Hz	1.2 Hz	243 Vrms	187 Vrms	400 Vpk
Swaziland	230 Vrms	50 Hz	1.3 Hz	244 Vrms	216 Vrms	400 Vpk
	400 Vrms	50 Hz	1.3 Hz	425 Vrms	376 Vrms	600 Vpk
Sweden	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
Switzerland	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
Syria	115 Vrms	50 Hz	1.0 Hz	127 Vrms	97 Vrms	200 Vpk
	200 Vrms	50 Hz	1.0 Hz	221 Vrms	170 Vrms	300 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Taiwan	110 Vrms	60 Hz	2.4 Hz	116 Vrms	104 Vrms	200 Vpk
	220 Vrms	60 Hz	2.4 Hz	232 Vrms	209 Vrms	400 Vpk
	380 Vrms	60 Hz	2.4 Hz	419 Vrms	342 Vrms	600 Vpk
Tanzania	230 Vrms	50 Hz	1.0 Hz	254 Vrms	195 Vrms	400 Vpk
	400 Vrms	50 Hz	1.0 Hz	441 Vrms	340 Vrms	600 Vpk
Thailand	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Togo	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Tonga	110 Vrms	50 Hz	1.0 Hz	122 Vrms	93 Vrms	200 Vpk
	240 Vrms	50 Hz	1.0 Hz	265 Vrms	204 Vrms	400 Vpk
	415 Vrms	50 Hz	1.0 Hz	457 Vrms	352 Vrms	600 Vpk
Trinidad/	115 Vrms	60 Hz	0.6 Hz	122 Vrms	108 Vrms	200 Vpk
Tobago	230 Vrms	60 Hz	0.6 Hz	244 Vrms	216 Vrms	400 Vpk
	400 Vrms	60 Hz	0.6 Hz	425 Vrms	376 Vrms	600 Vpk
Tunisia	220 Vrms	50 Hz	1.0 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	342 Vrms	600 Vpk
Turkey	220 Vrms	50 Hz	1.0 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	342 Vrms	600 Vpk
Uganda	240 Vrms	50 Hz	0.5 Hz	251 Vrms	229 Vrms	400 Vpk
United Arab	220 Vrms	50 Hz	0.5 Hz	225 Vrms	215 Vrms	400 Vpk
Emirates	380 Vrms	50 Hz	0.5 Hz	388 Vrms	372 Vrms	600 Vpk
	400 Vrms	50 Hz	0.5 Hz	413 Vrms	388 Vrms	600 Vpk
United	240 Vrms	50 Hz	0.5 Hz	255 Vrms	225 Vrms	400 Vpk
Kingdom	415 Vrms	50 Hz	0.5 Hz	440 Vrms	390 Vrms	600 Vpk
United States	120 Vrms	60 Hz	0.6 Hz	128 Vrms	105 Vrms	200 Vpk
	208 Vrms	60 Hz	0.6 Hz	221 Vrms	183 Vrms	300 Vpk
	240 Vrms	60 Hz	0.6 Hz	255 Vrms	211 Vrms	400 Vpk
	277 Vrms	60 Hz	0.6 Hz	294 Vrms	243 Vrms	400 Vpk
	480 Vrms	60 Hz	0.6 Hz	509 Vrms	422 Vrms	700 Vpk
Upper Volta	220 Vrms	50 Hz	1.0 Hz	203 Vrms	187 Vrms	400 Vpk
Uruguay	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
USSR	127 Vrms	50 Hz	1.0 Hz	140 Vrms	107 Vrms	200 Vpk
	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Venezuela	120 Vrms	60 Hz	1.2 Hz	133 Vrms	102 Vrms	200 Vpk
	208 Vrms	60 Hz	1.2 Hz	229 Vrms	176 Vrms	300 Vpk
	240 Vrms	60 Hz	1.2 Hz	265 Vrms	204 Vrms	400 Vpk
Vietnam	120 Vrms	50 Hz	0.5 Hz	133 Vrms	108 Vrms	200 Vpk
	208 Vrms	50 Hz	0.5 Hz	229 Vrms	187 Vrms	300 Vpk
	220 Vrms	50 Hz	0.5 Hz	243 Vrms	198 Vrms	400 Vpk
	380 Vrms	50 Hz	0.5 Hz	419 Vrms	342 Vrms	600 Vpk
Western Samoa	230 Vrms	50 Hz	1.0 Hz	254 Vrms	195 Vrms	400 Vpk

Recommended Thresholds

Use these thresholds to get started only if you lack other data about acceptable power for your application.

Country	Nominal Power		Recommended BMI PowerScope Thresholds			
	Voltage	Frequency	Frequency Tolerance	Surge	Sag	Impulse
Yemen Arab R.	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
Yemen	250 Vrms	50 Hz	0.5 Hz	261 Vrms	240 Vrms	400 Vpk
	440 Vrms	50 Hz	0.5 Hz	458 Vrms	422 Vrms	700 Vpk
Yugoslavia	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Zaire	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk
	380 Vrms	50 Hz	1.0 Hz	419 Vrms	323 Vrms	600 Vpk
Zambia	230 Vrms	50 Hz	1.0 Hz	239 Vrms	221 Vrms	400 Vpk
	400 Vrms	50 Hz	1.1 Hz	416 Vrms	385 Vrms	600 Vpk
Zimbabwe	220 Vrms	50 Hz	1.0 Hz	243 Vrms	187 Vrms	400 Vpk

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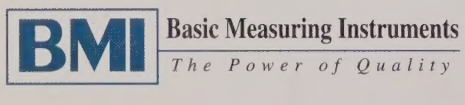

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